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Peninsula Restoration Group

Hackensack River Study Area
Remedial Investigation Report

June 2007

CERTIFICATION
Pursuant to N.J.A.C. 7:26C-1.2

Regarding the *Hackensack River Study Area Remedial Investigation Report* dated June 2007 (including all attachments and enclosures, the "Submission") submitted herewith and prepared by ARCADIS of New York, Inc. (known as ARCADIS BBL) for the Peninsula Restoration Group in connection with the investigation of an area of the Hackensack River adjacent to the Diamond Shamrock, Standard Chlorine Chemical and Koppers Seaboard sites located in Kearny, NJ ("Study Area"), the undersigned officer of ARCADIS BBL does state as follows:

"I certify under penalty of law that I have personally examined and am familiar with the Submission and that all the information provided therein is true, accurate and complete. I am aware that there are significant civil penalties for knowingly submitting false, inaccurate, or incomplete information, and that I am committing a crime of the fourth degree if I make a written false statement that I do not believe to be true. I am also aware that, if I knowingly direct or authorize the violation of any statute, I am personally liable for the penalties."

ARCADIS OF NEW YORK, INC.

By: _____ May 24, 2007
Robert Romagnoli — Date
Vice President

Sworn to and subscribed before me on this 24th day of May, 2007

_____
Signature of Notary Public

(Stamp and Seal/Commission Expiration Date)

JOYCE M. WHEELER
Notary Public In The State Of New York
Qualified In Onon. Co. No. 4239828
My Commission Expires Dec. 31, 2009

CERTIFICATION
Pursuant to N.J.A.C. 7:a6C-1.2

Based on the preceding Certification of Robert Romagnoli of Arcadis of New York, Inc. regarding the Submission (as such term is defined in that certification) each of the undersigned officers of Beazer East, Inc., Standard Chlorine Chemical Co., Inc and Tierra Solutions, Inc. does state as follows:

"I certify under penalty of law that I have personally examined and am familiar with the information submitted herein including all attached documents, and that based on my inquiry of those individuals responsible for obtaining the information contained, to the best of my knowledge, I believe the submitted information is true, accurate and complete. I am aware that there are significant civil penalties for knowingly submitting false, inaccurate, or incomplete information, and that I am committing a crime of the fourth degree if I make a written false statement that I do not believe to be true. I am also aware that, if I knowingly direct or authorize the violation of any statute, I am personally liable for the penalties."

BEAZER EAST, INC.

By: _____ 5/31/07
Robert Markwell . Date
Vice President

Sworn to and subscribed before me on this 31ST day of MAY, 2007

_____
Signature of Notary Public

(Stamp and Seal/Commission Expiration Date)

COMMONWEALTH OF PENNSYLVANIA
Notarial Seal
Donna Lee Kopach, Notary Public
City Of Pittsburgh, Allegheny County
My Commission Expires March 22, 2011
Member, Pennsylvania Association of Notaries

STANDARD CHLORINE CHEMICAL CO., INC.

By: Margaret W. Kelly 5/30/07
Margaret W. Kelly, Esq. Date
Vice President

Sworn to and subscribed before me on this 30 day of May, 2007

Signature of Notary Public

CRAIG WEXLER
NOTARY PUBLIC, STATE OF NEW YORK
Registration No. 01WE6071493
Qualified in New York County
Commission Expires March 18, 2010

(Stamp and Seal/Commission Expiration Date)

TIERRA SOLUTIONS, INC.

By: 5/29/07
David Rabbe Date
President

Sworn to and subscribed before me on this 29th day of May, 2007

Signature of Notary Public

(Stamp and Seal/Commission Expiration Date)

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Tables

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Acronyms and Abbreviations

1,2-DCB	1,2-dichlorobenzene
1,3-DCB	1,3-dichlorobenzene
1,4-DCB	1,4-dichlorobenzene
4,4-DDD	4,4-dichlorodiphenyldichloroethane
4,4-DDE	4,4-dichlorodiphenyltrichloroethylene
4,4-DDT	dichlorodiphenyltrichloroethane
1,2,4-TCB	1,2,4-trichlorobenzene
2,3,7,8-TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
˚C	degrees Celsius
°F	degrees Fahrenheit
ACO	Administrative Consent Order
Alta	Alta Analytical Laboratory
AUD	Acceptable Use Determination
AVS/SEM	acid volatile sulfides/simultaneously extracted metals
BAZ	biologically active zone
BBL	Blasland, Bouck & Lee, Inc.
Be-7	beryllium-7
Beazer	Beazer East, Inc.
BEE	Baseline Ecological Evaluation
BERA	Baseline Ecological Risk Assessment
BTEX	benzene, toluene, ethylbenzene and xylene
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
COI	constituent of interest
COPEC	constituent of potential ecological concern
COPR	chromite ore processing residue
Cs-137	cesium-137

CSO	combined sewer overflow
CSM	Conceptual Site Model
Dennis	Martin Dennis Company
DGPS	Digital Global Positioning System
Diamond Site	Former Diamond Shamrock Site
DNAPL	dense nonaqueous-phase liquid
DQO	data quality objective
EDL	estimated detection limit
EMPC	estimated maximum possible concentration
ESA	environmentally sensitive areas
ES-I	Enviro-Sciences, Inc.
ESI	Environmental Standards, Inc.
ft/sec	feet per second
GC/MS	gas chromatograph/mass spectrometry
GLDD	Great Lakes Dredge and Dock Company, LLC
GPS	Global Positioning System
HCIA	Hudson County Improvement Authority
H-PAH	high-molecular weight PAH
HRGC/LRMS	high-resolution gas chromatograph/low-resolution mass spectrometry
HRSA	Hackensack River Study Area
IBC	important bioaccumulative chemicals
ICP	inductively coupled plasma
ICPMS	inductively coupled plasma mass spectroscopy
ICP/CVAA	inductively coupled plasma/cold vapor atomic absorption
in/yr	inches per year
IRAW	Interim Response Action Workplan
IRM	interim remedial measure

Lancaster	Lancaster Laboratories, Inc.
LCS/LCSD	laboratory control sample/laboratory control sample duplicate
L-PAH	low molecular weight PAH
LEL	lowest effects level
LURP ODST	Land Use Regulatory Program, Office of Dredge Sediment Technology
MDL	method detection limit
mg/kg	milligram per kilogram
MLLW	mean lower low water
mm	millimeter
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
mph	miles per hour
MS/MSD	matrix spike/matrix spike duplicate
mV	millivolt
NAPL	nonaqueous-phase liquid
N.J.A.C.	New Jersey Administrative Code
NCP	National Contingency Plan
NHP	National Heritage Program
NJDEP	New Jersey Department of Environmental Protection
NJ TRSR	New Jersey Technical Requirements for Site Remediation
NOAA	National Oceanographic and Atmospheric Administration
NPL	National Priorities List
NWI	National Wetlands Inventory
NY/NJ	New York/New Jersey
OCDD	octachlorodibenzo-p-dioxin
OCDF	octachlorodibenzofurans
OPR	ongoing precision and recovery

ORP	oxidation-reduction potential
OSI	Ocean Survey, Inc.
PAH	polycyclic aromatic hydrocarbon
PAR	Pathways Analysis Report
Paragon	Paragon Analytics
Pb-210	lead-210
PCB	polychlorinated biphenyl
PCDD	polychlorinated dibenzo-p-dioxin
pCi/g	picocurries per gram
PCDF	polychlorinated dibenzofuran
PDM	processed dredge material
PE	performance evaluation
pg/g	picograms per gram
pH	potential of hydrogen
PODS	portable on-demand storage
PRG	Peninsula Restoration Group
PSE&G	Public Service Electric and Gas Company
PSEG SC	Public Service Electric and Gas Services Corporation
QA/QC	quality assurance/quality control
QDQ	qualitative data quality
RAO	remedial action objectives
RAWP	Remedial Action Work Plan
RAWPA	Remedial Action Work Plan Addendum
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RI Report	*Remedial Investigation Report*
River	Hackensack River
RIWP	*Remedial Investigation Work Plan*

RPD	relative percent difference
RT	retention time
SCCC	Standard Chlorine Chemical Company, Inc.
SDG	sample delivery group
Seaboard Site	Former Koppers Seaboard Site
Settlement Agreement	Settlement Agreement and Release
SK Services	Safety-Kleen Services
SLERA	screening-level ecological risk assessment
SLERA WP	*SLERA Work Plan*
S/N	signal to noise ratio
SOP	Standard Operating Procedure
SQG	Sediment Quality Guidelines
SQL	Sample Quantitation Limit
SRIR	*Supplemental Remedial Investigation Report*
SRIWP	*Supplemental Remedial Investigation Work Plan*
SSP	steel sheet pile
STL	Severn Trent Laboratories
SVOC	semivolatile organic compound
TAL	Target Analyte List
TCL	Target Compound List
TEQ	toxicity equivalent
TEPH	total extractable petroleum hydrocarbons
Tierra	Tierra Solutions, Inc.
TOC	total organic carbon
TPA	Three Party Agreement
TRV	toxicity reference values
µg/kg	microgram per kilogram
µL	microliters

UEL	upper effects limit
UPS	United Parcel Service
USACOE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
VOC	volatile organic compound

1. Introduction

This *Remedial Investigation Report* (RI Report) documents the field activities and resulting data associated with the Hackensack River Study Area (HRSA) Remedial Investigation (RI) conducted in October and November 2006. This RI Report has been developed by ARCADIS BBL (formerly known as Blasland, Bouck, & Lee, Inc. [BBL]) on behalf of Beazer East, Inc. (Beazer, formerly known as Koppers Company, Inc.); Standard Chlorine Chemical Co, Inc. (SCCC); and Tierra Solutions, Inc. (Tierra) — collectively referred to as the Peninsula Restoration Group (PRG).

The RI Program was conducted in accordance with the approved HRSA Remedial Investigation Work Plan (HRSA RIWP; BBL, 2005), associated addenda (July 2006, October 2006, and February 2007), and New Jersey Department of Environmental Protection's (NJDEP's) approval letter of June 22, 2006. The RIWP was developed and approved in a manner consistent with the New Jersey Technical Requirements for Site Remediation (NJ TRSR), New Jersey Administrative Code (N.J.A.C.) 7:26E et seq., and the separate obligations of Beazer, Tierra and SCCC under the Administrative Consent Orders (ACOs) entered separately by each concerning, respectively, the former Koppers Seaboard Site (Seaboard Site), the former Diamond Shamrock Site (Diamond Site), and the SCCC Site, all three of which abut the HRSA (collectively, the "Kearny Peninsula Sites"), to the extent such ACOs govern the work.[1] In addition, the PRG is undertaking a Remedial Investigation/Feasibility Study (RI/FS) for the HRSA in general accordance with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the National Contingency Plan (NCP), as cited in the NJDEP *Field Sampling Procedures Manual* (NJDEP, 2005) and N.J.A.C. 7:26E et seq.

The Hackensack River (River), part of the New York/New Jersey (NY/NJ) Harbor Estuary, is located at the northeast quadrant of Newark Bay and extends north into New York State (Figure 1-1). The HRSA encompasses approximately 2.7 miles of the lower Hackensack River (Figure 1-2). The PRG represents three of the upland

[1] Such ACOs refer to (a) that certain ACO entered into by and between NJDEP and Beazer dated March 1986; (b) that certain ACO entered into by and between NJDEP and SCCC dated October 1989 and; (c) that certain ACO entered by and among NJDEP and Occidental Chemical Corporation and Chemical Land Holdings, Inc [now Tierra], dated April 17, 1990.

properties abutting the HRSA: the SCCC, Diamond and Seaboard Site, as shown on Figure 1-2.

1.1 Site Investigation Approach

Through previous investigations, various constituents have been detected in sediment within the HRSA including, but not limited to, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), pesticides, polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs) and metals.

As discussed at the June 9, 2005 meeting between representatives of the PRG and the NJDEP, the goal of this RI Program was to obtain sediment quality data for the following purposes:

- determining preliminary nature and extent of constituents in HRSA sediments
- conducting a screening-level ecological risk assessment (SLERA)

Together with the HRSA Reconnaissance Program, which involved the collection of sediment thickness, bathymetry, habitat, and ecological data, the PRG believes that these two goals have been adequately met.

1.2 Report Organization

This RI Report has generally been structured in accordance and is consistent with the NJ TRSR. Section 1 provides an introduction to the RI Report, while Section 2 describes the HRSA. Section 3 discusses the RI Program implementation, and Sections 4, 5 and 6 present associated data (including the SLERA). Section 7 provides an overall summary of the RI Report, and Section 8 concludes with a list of references cited.

2. Site Description

This section of the RI Report provides an overview of the NY/NJ Harbor Estuary and Hackensack River regional conditions. The three upland properties that constitute most of the "Kearny Peninsula" of the lower Hackensack River (as shown on Figure 1-2) are then discussed, including a brief history of the associated industrial and remedial activities. A similar discussion of the HRSA (located adjacent to the three properties) concludes this section.

2.1 Regional Characteristics

The regional geologic and climatologic characteristics of the Hackensack River are described in this subsection.

2.1.1 Geologic Setting

The Hackensack River is situated within the Newark Basin portion of the Piedmont Physiographic Province, which itself is located between the Atlantic Coastal Province and the Appalachian Province. The Newark Basin is underlain by sedimentary rocks (sandstones, shales, limy shales and conglomerates), igneous rocks (basalt and diabase), and metamorphic rocks (schists and gneiss). Underlying bedrock consists of the Lockatong Formation (light to dark gray silty argillite and laminated mudstone that has been thermally metamorphosed to hornfels where intruded by diabase), Passaic Formation (interbedded red-brown sandstones and shales) and Jurassic diabase (dark gray to black, moderately fractured igneous rock [the Palisades]) (Nichols, 1968; National Oceanographic and Atmospheric Administration [NOAA], 1984; Drake et al., 1996).

Most of the River is underlain by the Passaic Formation, but the westernmost edge is underlain by a sliver of the Lockatong Formation that was split by Jurassic intrusion of diabase (the Palisades) (Lyttle and Epstein, 1987; Drake et al., 1996). The bedrock surface beneath the Hackensack River is highly irregular, having been shaped by preglacial and interglacial fluvial erosion and glacial scour. It contains numerous rock pinnacles and entrenched channels (Carswell, 1976; United States Army Corps of Engineers ([USACOE], 1997).

The land surface surrounding the Hackensack River has moderate relief and consists of rounded and elongated hills within a central lowland valley bracketed by long volcanic ridges. This landscape is predominantly an expression of remnant features of

Triassic volcanism and Pleistocene (Wisconsin-age) glaciation (Agron, 1980; Averill et al., 1980; USACOE, 1997).

2.1.2 Climate

Information provided by the USACOE (1987) indicates that the climate for the Hackensack River and surrounding areas is characteristic of the Middle Atlantic Seaboard, where marked changes in weather are frequent, particularly in the spring and fall. Winters are moderate, with snowfall averaging approximately 34 inches per year (in/yr) from October through mid-April. Summers are moderate with sporadic heat waves. Coastal areas are cooled by daytime winds off the Atlantic Ocean.

Rainfall is moderate and distributed fairly uniformly throughout the year, averaging approximately 47 in/yr, with an average of 121 rainy days per year. The region may be influenced by seasonal tropical storms and hurricanes between June and November, which can bring the heaviest rainfalls (Carswell, 1976). Thunderstorm and tropical storm activity is most likely to occur in the summer, although some occur in the fall and northeasters can occur from November to April.

The average annual temperature in Newark is 54 degrees Fahrenheit (°F), with extremes from -26°F to +108°F.

Based on data from the Newark Liberty International Airport, prevailing winds in the vicinity of the HRSA are from the southwest, with small seasonal variations in direction (www.wcc.nrcs.usda.gov/climate/ windrose.html). By season, the mean wind direction for the winter months is west-northwest (35 percent of the time), while southwest winds predominate (32 percent of the time) during the summer. Mean wind speeds are generally highest during the winter and spring months (10 to 12 miles per hour [mph]), and lower during the summer months (7 to 9 mph), with an average annual velocity of approximately 10 mph.

2.1.3 Environmental Setting

The Hackensack River rises in southeastern New York approximately one mile south of West Haverstraw in Rockland County and then flows south for approximately 32 river miles to discharge into Newark Bay. The Hackensack River watershed has a drainage area of approximately 165 square miles, and the HRSA is located in the lower reach of the River, just upstream of its mouth.

The Hackensack River watershed is one of the most populated watersheds in New Jersey, with approximately 50 percent of the land still undeveloped. The developed land is predominantly used for industrial and commercial purposes (70 percent), with the remaining portion (30 percent) used for residential purpose.

The Hackensack River remains the receiving surface water body for multiple industrial and municipal discharges as well as storm water runoff. Multiple well known potential current and historical sources of contamination exist along the Hackensack River; upstream, downstream and within the HRSA where the PRG sites are located. Attachment 1 provides an indication of the number and density of potential sources of River impacts. Clearly, some sources are much more significant than others, but the attachment helps to illustrate the industrial setting in which the HRSA is located.

2.2 Kearny Peninsula Sites History

The operational and remedial histories of the SCCC Site, Diamond Site and the Seaboard Site are described in this subsection.

2.2.1 Standard Chlorine Chemical Company Site

The SCCC Site occupies approximately 25 acres. The SCCC Site operational history is described in the RI Report prepared by Roy F. Weston, Inc. (1993). In summary, manufacturing operations were conducted on portions of the SCCC Site between 1916 and 1993 by various entities, including the White Tar Company (1916-1933), Koppers Company, Inc. (1933-1962), Standard Naphthalene Products Co., Inc. (1962-1980), SCCC, Inc. (1962-1981) and Cloroben Chemical Corporation (1962-1993). Operations included the refining naphthalenes; manufacturing products from naphthalene, naphthalene derivatives and dichlorobenzenes; formulating drain cleaning products; and, on a limited basis during the 1970s, processing trichlorobenzene (Key Environmental, Inc., 2004a). Fill materials were placed at the SCCC Site during the 1920s and 1930s to create property for industrial development. These fill materials generally consisted of chromite ore processing residue (COPR) soils and silty sand. According to the RI Report, COPR soils were placed as fill on approximately 85 percent of the SCCC Site to depths ranging between 2 and 10 feet below the present grade (Roy F. Weston, Inc., 1993).

Ten investigations were performed between 1984 and 2002 at the SCCC Site. Sample matrices included sediment, sludge, soil, groundwater and surface water (Key Environmental, Inc., 2004a). A preliminary hydrogeologic investigation was conducted

in 1984 and two investigations and characterization of lagoon contents were completed between 1984 and 1988. On October 20, 1989 SCCC entered into the SCCC ACO with the NJDEP to investigate and address site contamination Three remedial investigations were implemented at the SCCC Site pursuant to the SCCC ACO between 1989 and 1999: Phase I and Phase II site-wide RIs (Roy F. Weston, Inc., 1993), a focused RI for the eastern section of the property (Environmental Resources Management, Inc., 1997), and a site-wide supplemental RI undertaken by Safety-Kleen Services East, LLP (SK Services) on behalf of SCCC and completed by SCCC (Key Environmental, Inc., 1999). Additional characterization of containerized materials and soil and sediment sampling and analysis, were conducted in 2000 by Enviro-Sciences, Inc. (ES-I) on behalf of SCCC (ES-I, 2000).

A series of Interim Remedial Measures (IRMs) were completed by SCCC in 1990. The IRMs were completed in accordance with an NJDEP-approved work plan and included the following tasks:

- installing security fencing surrounding the former production area and lagoons
- adding soil to the lagoon berm to increase its height and freeboard
- placing geotextile and rip-rap along the Hackensack River shoreline in the vicinity of the lagoon
- removing the contents from five aboveground storage tanks
- repackaging the asbestos-containing material removed from the former distillation building

Additional IRMs, including the closure of an old production well, and closure of the septic tanks and sanitary lines) were conducted between 1995 and 2000 (Key Environmental, Inc. 2007a).

To mitigate potential risk of human exposure to the COPR soil at the property, IRMs were implemented by Maxus Energy Corporation (Maxus) in February 1991 in the western and central sections of the SCCC Site. The COPR IRMs were completed, and have subsequently been maintained, in accordance with an NJDEP-approved work plan and included the following:

- placing asphalt pavement over traffic areas with existing asphalt
- placing geotextile fabric, 4 inches of underlying dense graded aggregate and 4 inches of overlying asphalt on all remaining traffic areas
- constructing a surface cover in nontraffic areas west of the railroad right-of-way with geotextile/geomembrane liner overlain with 4 inches of dense graded aggregate
- constructing a dust fence barrier along the railroad right-of-way and north fence line to isolate the impacted surface soil in the former process area

In January 1997, a preliminary remedial action plan was submitted for the eastern third of the Site. This was not implemented due to a proposed acquisition of the site in connection with the Hudson County Improvement Authority's (HCIA) acquisition of the adjacent Seaboard Site.

A *Remedial Action Work Plan* (RAWP) was submitted to the NJDEP in November 2000 by ES-I on behalf of SCCC (ES-I, 2000). An addendum to the RAWP extended the proposed remedy to the Diamond Site and, responding to comments from the NJDEP, was submitted by ES-I in May 2001. The NJDEP did not review or act on the RAWP or addendum.

Instead, on the basis of a concern over the adequacy of financial assurances, the NJDEP referred the Site to the United States Environmental Protection Agency (USEPA) for the proposed addition to the National Priorities List (NPL). On April 30, 2003, the USEPA proposed that the SCCC Site be added to the NPL. However, the NJDEP "indicated a willingness to consider a request for deferral of the NPL listing if adequate financial assurance was provided for remediation under NJDEP's authority" and if the PRG agreed to fund and undertake the activities required under the SCCC ACO (Key Environmental, Inc., 2004a). The PRG provided the requested financial assurance for the SCCC Site, agreed to undertake the investigation and remediation of the SCCC Site pursuant to the SCCC ACO and, as applicable, the Tierra ACO, and the NJDEP requested a deferral of the NPL listing.

An Interim Response Action Workplan (IRAW) was submitted for the SCCC Site in March 2004. The NJDEP issued comments to the IRAW in April 2006 and a revised IRAW was submitted in June 2006. The NJDEP issued comments on the June 2006 IRAW on April 11, 2007. A revised IRAW incorporating the NJDEP's comments was

submitted to the NJDEP in May 2007 by the PRG (Key Environmental, Inc., 2007b). Available analytical data for the SCCC Site is summarized in the revised IRAW.

The May 2007 IRAW outlines proposed supplemental investigations and interim remedial response actions for the SCCC Site. Supplemental investigation activities include collecting relevant geotechnical data, characterizing near-shore Hackensack River sediments and obtaining other data necessary to complete the design of the various IRAW components. Proposed interim responses consist of installing a perimeter barrier wall system, hydraulic control (groundwater collection and treatment) within the containment, removal and on-site consolidation of Hackensack River sediments located within 50 feet of the proposed barrier wall, installing a dense, nonaqueous-phase liquid (DNAPL) recovery system, capping lagoon contents and installing a surface cover system in areas not previously address by the chromium IRMs.

2.2.2 Former Diamond Shamrock Site

The first chromate chemical manufacturing facility on the Diamond Site was constructed in 1916 by the Martin Dennis Company (Dennis). The facility imported chromite ore for use in the production of sodium bichromate for retail sale or use in manufacturing other chromium chemicals. In 1952, the facility also began producing chrome-based leather tanning agents called “Tanolin” and chromic acid. The production of sodium bichromate by Dennis and the Diamond Shamrock Chemicals Company continued until November 1971. Production of Tanolin and chromic acid, however, continued until 1976. Production at the facility was discontinued in December 1976 and the majority of the buildings were razed in 1978 (Brown and Caldwell, 2001).

Three investigations were performed between 1974 and 1985 at the Diamond Site, from which primarily soil and hydrogeologic data were produced (Brown and Caldwell, 2001). On April 17, 1990, Occidental Chemical Company (successor to Diamond) and Chemical Land Holdings, Inc. executed an ACO with the NJDEP to address COPR sites. The ACO requires that an RI be implemented at each COPR site to investigate the extent of chromium contamination in the soils, groundwater, air, surface waters and sediments, and to assess potential impacts to human health and the environment (Brown and Caldwell, 2001). The Diamond Site, located on the Kearny Peninsula, was one of the sites to be addressed under the ACO.

Following execution of the ACO, it was determined that four IRMs were required at certain areas of the Diamond Site. Subsequently, four separate IRMs have been

implemented at multiple locations at the Diamond Site, including the following (Brown and Caldwell, 2001):

- A geotextile fabric/geomembrane liner composite and 4 inches of overlying dense graded aggregate were placed over existing soils along the eastern section of the Diamond Site (parallel to the Belleville Turnpike), in two central areas of the Diamond Site and along the Amtrak embankment in the northeast corner of the Diamond Site

- A geotextile fabric/geomembrane liner composite and overlying rip-rap were placed over the existing soils along the bank of the Hackensack River

- A 4-inch-thick layer of bituminous asphalt, 4 inches of underlying dense graded aggregate and an underlying geotextile fabric were placed over existing soils along a majority of the eastern portion of the Diamond Site

- A 2-inch-thick layer of asphalt was placed over existing pavement along the entrance roadway and within a portion of the Diamond Site around the former production buildings

The RI Report for the Diamond Site was submitted to the NJDEP in April 2001 (Brown and Caldwell, 2001). The primary constituent of interest (COI) for the Diamond Site is hexavalent chromium, and is contained within COPR-contaminated fill material. The NJDEP issued comments to the RI Report in December 2005. In February 2006, Tierra submitted responses to the NJDEP comments and in March 2006, a *Supplemental RI Work Plan* (SRIWP) was submitted to the NJDEP by Tierra. The SRIWP proposes additional soil and groundwater investigation as requested in the NJDEP's December 2005 comments.

A draft IRAW was submitted for the Diamond Site in March 2004. The NJDEP issued comments to the draft IRAW in April 2006 and a revised IRAW was submitted in June 2006. The NJDEP issued comments to the June 2006 IRAW on April 11, 2007. A revised IRAW incorporating the NJDEP's comments was submitted to NJDEP in May 2007 by the PRG (Key Environmental, Inc., 2007). Components of the IRAW for the Diamond Site are an extension of those proposed for the SCCC Site, as described previously. Interim responses proposed in the June 2006 IRAW consist of installing a perimeter barrier wall system, hydraulic control (groundwater collection and treatment) within the containment, and removal of Hackensack River sediments located within 50 feet of the proposed barrier wall.

2.2.3 Former Koppers Seaboard Site

The Seaboard Site is the location of a former integrated coke plant, tar plant and coke byproducts facility, and is currently owned by the HCIA. The Seaboard Site occupies approximately 174 acres, with 131 of those being located above the mean high water level. The Seaboard Site is being addressed in accordance with a March 1986 ACO between Koppers Company and the NJDEP.

HCIA, Safety-Kleen Services (East), L.C. (formerly ECDC Environmental, L.C.) and Beazer developed a plan to remediate the Seaboard Site. Remedial actions included the use of processed dredge material (PDM) originating from the NY/NJ Harbor as an engineering control. A "White Paper" (Beazer, 1996) and a March 4, 1997 Memorandum of Understanding (MOU) between the NJDEP, Beazer, SK Services and the HCIA (Beazer, 1997), collectively identified the remedial action objectives (RAOs) and proposed remedies for the Seaboard Site. Additional requirements and specific roles for implementation of remedial and redevelopment activities at the Seaboard Site were outlined in a Three Party Agreement (TPA) entered into between HCIA, SK Services and Beazer in February 1997. Also, the parties prepared and submitted to the NJDEP a "Scoping Letter" that presented a detailed list of activities to be conducted to support preparation of a RAWP for remediation of the Seaboard Site (Key Environmental, Inc., 1997).

Based on the Scoping Letter, MOU and TPA, SK Services, prepared and submitted a RAWP for the Seaboard Site Remedy (Key Environmental, Inc., 1998) and the NJDEP approved the RAWP in May 1998. The seven primary remedial components outlined in the RAWP for the Seaboard Site included:

- installing separate sheetpile and PDM Key barrier walls and the use of PDM as an engineering control
- excavation and on-site consolidation of near-shore sediments
- on-site stabilization and consolidation of site waste materials
- recovery of DNAPL for a defined period
- groundwater natural attenuation
- off-site disposal of the contents of a former storage tank

- implementing institutional controls

Following approval of the RAWP, SK Services conducted the following activities:

- installed the sheetpile barrier wall and partially installed the PDM Key barrier
- installed a significant portion of the surface cover
- consolidated a portion of the on-site waste materials
- installed and has operated a DNAPL recovery system
- conducted long-term monitoring of natural attenuation of COIs in groundwater
- removed and disposed off-site the contents (tar and naphthalene) of a 1,000,000-gallon aboveground storage tank and the tank itself
- located and closed two deep wells on site

In addition, work on the deed restrictions has been initiated. As a result of SK Services' bankruptcy and its failure to win additional dredging contracts, some RAWP remedial components remain to be completed, constituting approximately 30 percent of the originally planned RAWP work. The work to be completed includes completing the PDM Key, which will be completed as a slurry wall; dredging and consolidation of sediments outside the sheetpile wall and in the western area of the Seaboard Site; consolidation of waste piles in the western areas of the Seaboard Site; and grading of the PDM across the Seaboard Site.

In 2003 Beazer, HCIA, SK Services and its bonding company, and the New Jersey Meadowlands Commission executed a Settlement Agreement and Release (Settlement Agreement) pursuant to which Beazer is completing the remaining RAWP remedial components and the HCIA will complete development-related activities.

In October 2003, a Remedial Action Report and Progress Report were submitted to the NJDEP to document the remediation activities completed and those remaining to be completed (Key Environmental, Inc., 2003). In accordance with the Settlement Agreement, and in response to a February 10, 2004 letter from the NJDEP (NJDEP, 2004b), Beazer submitted a RAWP Addendum (RAWPA) to the NJDEP (Key Environmental, Inc., 2004b). The RAWPA proposed minor modifications to a few of the

remaining remediation components and included a schedule to complete the work. The RAWPA also explained how the proposed modifications meet the Seaboard Site RAOs.

As a result of continuing discussions with the NJDEP, Beazer submitted a revised RAWPA for the Seaboard Site in March 2007 (Key Environmental, Inc., 2007a). The March 2007 RAWPA outlines planned supplemental investigations and remedial responses for the Seaboard Site. Supplemental investigation activities include collecting sediment characterization data for near-shore Hackensack River sediments. Planned remedial responses consist of completing a barrier wall system inboard of the existing steel sheet pile (SSP) barrier wall, consolidation and on-site management of target materials including on-site materials and near-shore sediments (i.e., those located within 50 feet of the existing SSP barrier wall), installation of an in-situ permeable treatment system to enhance natural attenuation, upgrading the existing nonaqueous-phase liquid (NAPL) recovery system installed as an IRM and installation of a surface cover system consisting of PDM. NJDEP comments to the RAWPA have not been issued to date.

Great Lakes Dredge and Dock Company, LLC (GLDD) leased a 20-acre portion of the Seaboard Site from the HCIA for unloading, processing and shipment of dredge material. GLDD has obtained an Acceptable Use Determination (AUD) from the NJDEP's Land Use Regulatory Program, Office of Dredge Sediment Technology (LURP ODST) for their site activities. In accordance with an agreement between the HCIA and GLDD, an additional 400,000 cubic yards of PDM supplied by GLDD will be used on site as structural fill. The additional PDM provided by GLDD will meet remediation requirements for the Seaboard Site. Accordingly, the GLDD operational plans have been integrated into the remediation activities and thus have been included in the final RAWPA.

2.3 Hackensack River Study Area

The HRSA constitutes a 2.7-mile segment of the lower Hackensack River and stretches from 0.5 mile upstream of the Diamond Site to 0.5 mile downstream of the Seaboard Site. As shown on Figure 1-2, the SCCC Site is located between the Diamond and Seaboard Sites. More detailed information regarding this stretch of river is presented below.

2.3.1 Previous HRSA Sediment Investigations

Several investigations have been performed within and proximal to the HRSA, including several adjacent to the three upland sites. Summaries of these investigations (including those associated with the HRSA RI/FS Program) are presented in this subsection.

2.3.1.1 Reconnaissance Investigation Program

The HRSA Reconnaissance Program, which served as a precursor to this RI, took place between November 2004 and May 2005, and consisted of the following three tasks:

- Task 1 — Data Compilation and Review
- Task 2 — Collection of Field Data and Information
- Task 3 — Source Identification

A *Reconnaissance Investigation Report for the Hackensack River Study Area* was submitted to the NJDEP on May 25, 2005, detailing the findings of the study (BBL, 2005b). In general, Task 1 consisted of collecting and reviewing historical literature (including pertinent data) that described and/or quantified various features of the River. This task assisted in focusing the reconnaissance effort, and was useful in designing the approved HRSA RIWP (BBL, 2005a). Approximately 260 documents containing historical data and information were collected at that time. This database continues to be updated as additional materials are collected.

Task 2 included implementing a field-based investigation that was meant to characterize HRSA physical features, such as water depths, soft sediment depths and ecological habitat. Information pertaining to river depth and morphology was collected from the bathymetric survey data, while side-scan sonar data were used to characterize the surficial textures of the riverbed and identify potential debris. Soft sediment depths were determined by physically probing along 30 transects spaced 500 feet apart throughout the HRSA. These probing depths were useful in designing the number and location of cores collected as part of the RI.

As further described in Section 2.3.2.3, both sides of the shoreline were inspected by boat during high and low tides. During high tide, observations were made of types of

shoreline stabilization, adjacent land use and vegetation at and above the high tide line. Observations of mudflats, habitat, outfalls and other pertinent features were also made, where possible. Mudflat locations and length, intertidal vegetation, depositional characteristics and outfalls/discharge points were documented during low tide.

Task 3 centered on identifying potential sources to the HRSA including, but not limited to, permitted and unpermitted direct or indirect dischargers, potential groundwater discharges, publicly owned treatment works, stormwater outfalls and combined sewer overflows (CSOs). This final task was initiated as part of the Reconnaissance Program and is currently ongoing.

2.3.1.2 Other Sediment-Specific Investigations

Sediment-specific investigations were conducted adjacent to the Diamond and SCCC Sites. To date, no sediment investigations have been conducted adjacent to the Seaboard Site. Investigations are discussed below.

Diamond Site

Near-shore sediment investigations in the Hackensack River along the Diamond Site were completed in 1991 through 1993 and 2004 on behalf of Tierra. In 1991 through 1993, sediment samples were collected along five transects in the Hackensack River along the Diamond Site shoreline. Except for the northern-most transect, three sediment samples were collected from each transect. At the northern-most transect, only the sediment sample nearest to the shore could be collected as a result of the lack of recoverable sediments, likely a result of swift currents beneath the nearby railroad bridge. Sediment samples were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, PCBs, hexavalent chromium and target analyte list (TAL) metals. A summary of the analytical results obtain during this phase of sediment investigation is provided in the 2001 Remedial Investigation Report (Brown and Caldwell, 2001).

Sediment samples were also collected in April and October 2004. In April, sediment samples were collected in accordance with the April 2004 *Field Sampling Plan, Former Diamond Site (Site 113) Sediment Sampling* (Brown and Caldwell, 2004). The field sampling plan included collecting 30 surface sediment samples along five transects (six samples per transect). Due to the lack of surface sediment, a total of 16 samples were collected. In October 2004, sediment samples were collected in accordance with the October 2004 *Phase II Field Sampling Plan, Former Diamond Site (Site 113)*

Sediment Sampling (Brown and Caldwell, 2006). The field sampling plan included collecting 20 surface sediment samples along nine transects (two samples along eight transects each and four samples along one transect). A total of 17 samples were collected. Due to the lack of surface sediment, sediment recovered from two sampling locations was combined to make one sample. The samples were analyzed for total chromium, hexavalent chromium, metals, acid volatile sulfide/simultaneously extracted metals (AVS/SEM), VOCs, SVOCs, pesticides, PCBs, total organic carbon (TOC), grain size and porewater ammonia and salinity. A summary of the analytical results obtain during this phase of sediment investigation was provided to the NJDEP in a submittal dated March 31, 2006 (Brown and Caldwell, 2006).

SCCC Site

Near-shore sediments in the Hackensack River were characterized via sampling and analyses conducted by ES-I (in 2000) and the USEPA (in 2002). ES-I collected surficial sediment samples from nine locations in the River adjacent to the SCCC Site. These samples were analyzed for VOCs, base/neutral extractable organic compounds (including a scan for dioxin), priority pollutant metals, hexavalent chromium, TOC and particle size distribution. A summary of the analytical results obtain during this phase of sediment investigation was provided to the NJDEP in a submittal dated May 2007 (ES-1, 2000).

The USEPA collected sediment samples at three locations adjacent to the SCCC Site. A fourth location was located north of the SCCC Site and was designated by the USEPA as a “background” location. Sediment samples collected during this program were analyzed for target compound list (TCL) VOCs, TCL SVOCs, TAL metals, pesticides and PCBs, dioxins and furans and TOC. Tierra collected split sediment samples at the locations sampled by the USEPA and analyzed the samples for hexavalent chromium by USEPA SW-846 Methods 3060A/7199 (Key Environmental, Inc., 2007b).

Public Service Electric and Gas Company Services Corporation Site

A sediment investigation was completed in November 2005 by Public Service Electric and Gas Company Services Corporation (PSEG SC) on behalf of Public Service Electric and Gas Company (PSE&G) to comply with a Memorandum of Agreement (MOA) established between the NJDEP and PSE&G dated April 30, 1998. The objective of the investigation was to delineate oil and tar material in sediment along the PSE&G Facility known as the West End Gas Works located in Jersey City, and along

the HRSA shoreline. The program focused on delineating the horizontal and vertical extent of oil and tar material in sediment, collecting and analyzing sediment samples to complete a Baseline Ecological Evaluation (BEE), and evaluating the presence of other sources of PAHs upstream and downstream of the facility (PSE&G, 2006).

As reported in the *Supplemental Remedial Investigation Report* (SRIR), dated April 2006 and prepared by PSEG SC, 35 sediment borings were installed to delineate oil and tar material during the investigation program, including five upstream and five downstream locations, six shallow and six deep near-shore locations, and 11 step-out locations. Samples were collected and analyzed for TCL VOCs, TCL SVOCs, TCL pesticides/PCBs, herbicides, TAL inorganics, hexavalent chromium, total extractable petroleum hydrocarbons (TEPH), creosote, dioxins, TOC, grain size and carbon isotope ratio fingerprinting (PSE&G, 2006).

Results of the investigation confirmed that oil and tar material in sediment adjacent to the PSE&G Facility are associated with the PSE&G Facility, that constituents were detected in sediment samples at concentrations greater than screening criteria, and that an upstream and a downstream source of PAHs other than the PSE&G Facility appear to exist (PSE&G, 2006).

2.3.2 HRSA Description

Physical characteristics of the HRSA, including channel and nonchannel areas, shoreline, ecological and hydrodynamic characteristics, are summarized in this subsection.

2.3.2.1 Channel Areas

The HRSA encompasses one USACOE-defined navigation reach (Marion), along with a Turning Basin, as shown on Figure 1-2. According to the November 1997 NOAA navigation chart (NOAA, 1997), the Marion Reach extends approximately 2.1 miles northeast from the terminus of Droyer's Point Reach to the Turning Basin. The navigation channel is approximately 300 feet wide, with depths up to 30 feet below mean lower low water (MLLW).

According to the November 1997 NOAA navigation chart (NOAA, 1997), the Turning Basin extends approximately 1,215 feet northwest from the terminus of the Marion Reach. The Turning Basin ranges in width from 300 to 800 feet, with a depth 25 feet below MLLW.

2.3.2.2 Nonchannel Areas

Areas not classified as a channel are identified as a side channel, a near-shore region, or a mudflat. These areas each have slightly different bathymetric characteristics that result in hydrodynamic differences.

The side channels neighbor the center channel, are constantly submerged and have a depth up to 20 feet. The near-shore regions have a depth up to 6 feet and are tidally influenced, exposing some sections during low tide. These shallow, near-shore regions are anticipated to have a unique depositional pattern due to the tidal influence over this area.

The mudflats are areas along the shoreline that are approximately at the River water surface level and are also tidally influenced sections. These inter-tidal mudflats provide substrate for benthic organisms and foraging habitat for terrestrial animals. Twelve mudflats, as depicted on Figure 2-1 (with select photographs provided on Figure 2-2), were identified within the HRSA during the Reconnaissance Program.

2.3.2.3 Shoreline

The HRSA has a diverse shoreline ranging from heavily industrialized to open fields. As observed from 2002 aerial photographs acquired by Intrasearch (Englewood, Colorado), the Jersey City shoreline, located on the eastern side of the River, is an industrialized and developed area with several large buildings, oil tanks and docking areas. The Secaucus shoreline, also on the eastern side of the River and north of Jersey City, is less developed (primarily consisting of landfills). Photographs of these shoreline types are provided on Figure 2-2.

As indicated previously, the PRG made shoreline observations from a boat while navigating along the HRSA during the Reconnaissance Program. Two shoreline events were performed (one during high tide and one during low tide) to evaluate features during different tidal stages.

As presented in Table 2-2, the western shoreline of the HRSA is predominantly composed of riprap and bulkhead structures, with only minor occurrences of vegetated sections. Conversely, the composition of the eastern shoreline was found to be more diverse, with a more even distribution of vegetated and developed sections.

Sewer, CSO and industrial outfalls serve as potential flow and constituent sources to the HRSA. Prior to the Reconnaissance Program, preliminary reviews of public records identified seven permitted outfalls within the HRSA. Each of these seven outfalls was located, described and photographed as part of the Reconnaissance Program during a low tide event. An additional nine open pipe outfalls and four additional outfalls with tide gates were also located during this field investigation, as shown on Figure 2-1.

2.3.2.4 Ecology

Various types of shoreline habitat for both terrestrial and aquatic animals were identified within the HRSA during the Reconnaissance Program. These habitats include old pilings, decaying wooden bulkheads, rock piles, mudflats and tidal marshes. The location of shoreline habitats was recorded using Digital Global Positioning System (DGPS) coordinates and each habitat was described and photographed. Figure 2-2 presents locations of significant habitats and corresponding photographs. Refer to Table 2-2 for the approximate lengths of different types of shoreline composition.

Wildlife observations were also recorded during the Reconnaissance Program. Observations from a boat included species identification (or lowest possible taxa), type of sighting (i.e., fly-over, perched, feeding) and estimated number of individuals when groups were observed. The habitat in which the wildlife species was observed was also recorded. The results of such observations are provided in Table 2-3.

2.3.2.5 Hydrodynamics

The Hackensack River experiences a tidal range of approximately 5 feet. The tidal influence is responsible for the fairly high salinity levels at mouth, but low vertical density stratification upstream. The tidal velocity at the mouth is approximately 1.9 feet per second (ft/sec) (Marshall, 2004; Pence, 2004) and 2.6 ft/sec in the HRSA (Pence, 2004). These tides bring saltwater as far upstream as the Oradell Dam.

The flow of freshwater in the Hackensack River has been reduced through time by diversion into municipal water systems. The Hackensack Water Company was created in the late 1860s to supply the cities of Hoboken, Weehawken and Hackensack. Starting in 1901, the water company began constructing dams and reservoirs throughout the Hackensack River watershed, initially at Woodcliffe and later at Oradell and Clarkstown. These reservoirs reduced the flow of freshwater in the River, resulting in saltwater influence to move further upriver. In addition, dredging operations have

allowed for more saltwater migration upriver, and is a potential reason for this system behaving uncharacteristic of a typical river (Marshall, 2004). Suszkowski (1978) computed that much of the freshwater in the Hackensack River is composed of discharge from wastewater treatment facilities.

3. Implementation of the HRSA RI Program

This section summarizes the activities undertaken as part of the HRSA RI Program, conducted between October 16 and November 10, 2006. Activities completed during the RI Program were performed in accordance with procedures outlined in the approved HRSA RIWP (BBL, 2005a), and subsequent addenda.

In general, the RI Program consisted of the following activities:

- premobilization and mobilization
- sediment collection
- core transport and storage
- core processing and sample collection
- sample handling, preservation and shipment to laboratories
- laboratory analysis
- data validation
- completeness calculations
- data usability
- data management

Each activity is described in this section. The standard operating procedures (SOPs) referred to throughout are associated with the approved HRSA RIWP (BBL, 2005a).

3.1 RI Program Field Activities

The following describes the various activities implemented as part of the RI Program.

3.1.1 Premobilization Activities

Prior to initiating the actual field work, the following premobilization activities were completed: site permitting, laboratory selection and audits, and utility identification/clearance. Each is discussed in more detail below.

3.1.1.1 Site Permitting

The use of temporary trailer and storage containers at the processing area required electrical and building permits from the Town of Kearny, New Jersey and a temporary zoning certificate from the Meadowlands Commission. The Meadowlands Commission issued a temporary zoning certificate to the HCIA and ARCADIS BBL on October 2, 2006, which was then provided to the Town of Kearny on October 3, 2006 to obtain an electrical and building permit. Both permits were approved by the Town of Kearny for this project.

3.1.1.2 Laboratory Selection and Audits

Four New Jersey-certified laboratories were selected for use during the HRSA RI Program. Vista Analytical Laboratory, Inc. (formerly Alta Analytical Laboratory, Inc. [Alta]) of El Dorado Hills, California provided dioxin/furan and congener PCB analyses; Severn Trent Laboratories (STL) Pittsburgh of Pittsburgh, Pennsylvania provided VOC, SVOC, pesticide, herbicide, Aroclor PCB, TAL metal, cyanide, AVS/SEM and percent moisture analyses; Lancaster Laboratories, Inc. of Lancaster, Pennsylvania (Lancaster) provided TEPH, hexavalent chromium, grain size, TOC, potential of hydrogen (pH), oxidation-reduction potential (ORP) and percent moisture analyses; and Paragon Analytics of Fort Collins, Colorado (Paragon) provided radiochemistry analyses.

Laboratory audits were conducted on behalf of the PRG by Environmental Standards, Inc. (ESI) personnel at three of the four chosen laboratories. The audit was conducted on October 3, 2006; the STL audit was conducted on October 5, 2006; and the Lancaster audit was conducted on October 10, 2006. Paragon Analytics was previously audited in September 2005, and was not re-audited as part of this program.

The audits were performed to satisfy the requirements detailed in Section 7.2.2 of the approved HRSA RIWP (BBL, 2005a) and to provide feedback on laboratory operating issues with respect to method compliance, laboratory systems and good laboratory practices. The audits were conducted prior to initiating field work so that feedback

could be provided promptly to the participating laboratories if corrective action was deemed necessary. The audit reports for each laboratory are included in Appendix A. With very few exceptions, the audits found that the laboratories were adhering to the project-specific methods and quality assurance requirements.

3.1.1.3 Utility Identification and Clearance

This task included identifying utilities located along the HRSA, in cooperation with New Jersey One Call. At the onset, New Jersey One Call identified 23 companies potentially having underground utilities within the vicinity of the HRSA. The 23 companies were contacted by ARCADIS BBL to evaluate whether proposed coring locations conflicted with their respective underground utilities.

Upon completing the process, several proposed coring locations were modified to provide for an adequate buffer. Specifically, three core locations (007, 008 and 034) required relocation due to conflicts with utilities. To maintain consistency with collecting cores along specified transects, Transects 7 and 25 were shifted to comply with utility clearance requests. In doing so, core location 007 was moved approximately 50 feet northeast, core location 008 was moved approximately 100 feet southwest and core location 034 was moved approximately 50 feet north. These unavoidable modifications were communicated to Mr. Christopher Kanakis of the NJDEP in an October 18, 2006 letter from Mr. Mitchell Brourman of the PRG.

3.1.2 Mobilization Activities

Following premobilization tasks, several mobilization activities were completed in preparation for actual sediment collection: equipment decontamination, site set-up, tide gage installation and vessel mobilization. Each is discussed in detail below.

3.1.2.1 Equipment Decontamination

Prior to initiating field sampling activities, sampling equipment was decontaminated in accordance with SOP No. 3 — Decontamination. Equipment was decontaminated using a methanol/hexane rinse, as opposed to an acetone-only rinse, as acetone is a common laboratory contaminant. As part of this process, core tubes and caps were decontaminated on September 13, 2006 and one rinse blank sample was collected and analyzed for the list of parameters specified for water in Table 6-9 of the approved HRSA RIWP (BBL, 2005a).

Prior to the start of sediment collection activities on October 19, 2006, the remaining sampling and processing equipment was decontaminated. To track the equipment that was used to collect and process each core, this decontaminated equipment was divided into two groups. Sampling equipment used to collect cores on one day was paired with processing equipment then used to process those same cores. For implementation, the two groups were designated as “red” and “blue,” and staged in appropriately colored bins and shelving.

One rinse blank was collected on October 19, 2006 for the first group of sampling and processing equipment, and one rinse blank was collected for the second group of equipment after it was rotated into field use. The two sets of equipment were fully decontaminated on alternate days for the remainder of sediment collection and processing activities.

3.1.2.2 Site Set Up

Prior to the initiation of sampling, processing equipment was secured at the Seaboard Site. This equipment included a sample/core processing trailer, refrigerated container, portable storage unit, 55-gallon steel drums, water tank and other miscellaneous sampling and processing equipment.

3.1.2.3 Tide Gage Installation

A tide gage was installed on October 24, 2006 to collect water level measurements continuously during core collection activities. Figure 3-1 depicts the location of the tide gage. The data generated by the tide gage are presented in Appendix B.

3.1.2.4 Vessel Mobilization

On October 23, 2006, Ocean Survey, Inc. (OSI) mobilized a coring vessel to the HRSA. The vessel, a 37-foot pontoon barge (R/V CANDU), was equipped with (among other essential marine equipment) the following or equivalent instrumentation and equipment: an OTF RTK Global Positioning System (GPS), HYPACK Max marine survey positioning software and an OSI Model 1200 vibratory corer. The R/V CANDU is specifically designed by OSI for sediment core collection.

ARCADIS BBL also mobilized a coring vessel on October 24, 2006 for collection of mudflat cores. The vessel was equipped with a handheld GPS unit and hand coring device.

The OSI coring vessel was launched from the Passaic River Yacht Club, located on the Hackensack River approximately one mile south of the HRSA, while the ARCADIS BBL boat was launched from Laurel Hill County Park, approximately one mile north of the HRSA.

3.1.3 Sediment Collection

In accordance with the procedures outlined in the approved HRSA RIWP (BBL, 2005a), sediment was collected using vibracoring, hand coring and grab sampling techniques.

As shown in Figure 3-1, a total of 37 cores were collected along 15 transects spaced approximately 1,000 feet apart. The target depth of the sediment cores varied from 2 to 12 feet based on sediment thickness information obtained during the Reconnaissance Program. Samples for radiochemical analyses were obtained from six locations expected to be long-term depositional areas.

In addition, nineteen shallow cores (top 6 inches) were collected from six of the twelve mudflats identified as part of the Reconnaissance Program.

The following subsections summarize the various core collection activities.

3.1.3.1 Core Collection using Vibracore

OSI, together with ARCADIS BBL oversight and assistance, collected cores using a boat-mounted vibracorer in accordance with SOP No. 5 — Positioning and SOP No. 7 — Sediment Collection Using a Vibracoring Device. Following positioning over the core location using GPS, the core tubes were advanced through the sediment. To obtain a plug at the bottom of the core and to minimize sediment loss during retrieval, cores were typically advanced 1 foot beyond the target coring depth. Core catchers were also employed during the core collection process to minimize sediment loss during core retrieval. To prevent possible sediment disturbance and mixing, cores were kept upright at all times during collection and storage on the coring vessel.

Cores were collected at 37 of the 38 proposed locations along the HRSA. Figure 3-1 depicts the actual locations, and Table 3-1 lists the surveyed coordinates of these locations.

Minor modifications relative to the approved HRSA RIWP (BBL, 2005a) were instituted during the collection efforts. As part of this, secondary cores were collected at all locations (not just those associated with radiochemical analysis) to provide for adequate sample mass in the 0- to 0.5-foot interval. Secondary cores were co-located and offset to within 10 feet of the primary core, and were collected using the same equipment and procedures as the primary core.

Primary cores collected at locations 001, 007, 029 and 033 were comprised entirely of clay, and therefore did not provide adequate sediment for collection of laboratory samples. A second attempt was made at each location, resulting in the ultimate collection of sediment at locations 001, 007 and 029. Three attempts were made at location 033, in accordance with SOP No. 5 — Positioning and No.7 — Sediment Collection Using a Vibracoring Device, with only clay being recovered during each attempt. As a result, no sediment samples were obtained from coring location 033.

In addition to the above and, as discussed in Section 3.1.1, three core locations (007, 008 and 034) required relocation due to conflicts with utility lines in the area.

3.1.3.2 Collection by Hand Coring

Hand cores were collected at all 19 planned mudflat locations. These cores were collected using a hand corer in accordance with SOP No. 5 — Positioning and SOP No. 6 — Sediment Collection Using a Hand Coring Device. Figure 3-1 presents the actual locations of the hand cores collected, and Table 3-1 lists the surveyed coordinates of these locations.

Similar to sediment cores collected by vibracoring, two hand cores were collected at each mudflat location (i.e., a primary and a secondary core) to provide sufficient sample mass for chemical characterization. Secondary cores were co-located and offset to within 10 feet of the primary core, and were collected using the same equipment and procedures as for the primary core.

Following positioning over the core location using GPS, the core tubes were advanced by hand until the target depth was achieved, or refusal was met. The core was removed from the sediment by slowly pulling up out of the sediment using a twisting motion. The use of core catchers was not required during collection of hand cores. To prevent possible sediment disturbance and/or mixing, cores were kept upright at all times during collection and storage upon the coring vessel.

3.1.3.3 Collection by Grab Sampling

Grab samples were collected from all six planned locations n accordance with SOP No. 5 — Positioning and SOP No. 8 — Sediment Collection for Be-7 Analysis Using Grab Sample Device. Figure 3-1 presents the actual locations of the grab samples collected, and Table 3-1 lists the surveyed coordinates of these locations.

Following positioning over the grab sample location using GPS, a ponar dredge was lowered by hand to the sediment surface. Upon contact with the sediment surface, the spring-loaded device closed shut, collecting one sediment sample from approximately the uppermost 6 inches of sediment. The device was then retrieved by hand, with samples collected directly from the interior of the device.

3.1.4 Sediment Transport and Storage

Cores were transported and stored in accordance with procedures outlined in SOP No. 6 — Sediment Collection Using Hand Coring Device, SOP No. 7 — Sediment Collection Using Vibracoring Device and SOP No. 9 — Core Processing. Following collection on the respective vessels, cores were stored upright in an onboard cooler capable of keeping them cold. At the end of each coring day, cores were unloaded from the vessel into a box truck and transported from the marina to the processing facility, located at the Seaboard Site. The cores were then unloaded from the box truck and placed in the secured refrigeration storage container overnight. Using automatic temperature controls, a maximum temperature of 4 degrees Celsius (°C) was maintained in the refrigerated storage container. Cores were maintained upright at all times during the entire transportation process.

3.1.5 Sediment Processing and Sample Collection

Cores collected both by vibracoring and hand coring were processed in accordance with SOP No. 9 — Core Processing. A total of 199 sediment samples were collected during RI activities: 132 for chemical and geotechnical analysis and 67 for radiochemical analysis. For those cores designated for both chemical and radiochemical analyses, samples for each were collected from the same core, as described below.

Prior to processing for sample collection, photographs of the intact cores were taken. For the 0- to 0.5-foot segment, cores were processed in accordance with the procedure for high-water-content sediments. Excess water was drained from the top of the cores

by drilling a series of holes above the sediment-water interface, with any remaining free water removed using a stainless steel spoon. For cores requiring sections for chemical analysis only, a mark was made on the outside of the core tube at 0.5 feet (adjusted based on core percent recovery) from the top of sediment. Samples for VOC, AVS/SEM and moisture content analyses were collected directly from undisturbed sediment. The remaining sediment was transferred to stainless steel bowls for lithological description (see Appendix C), photologging and homogenization for further sampling.

For subsequent sample intervals, cores were processed in accordance with the procedure for processing non-high-water-content sediments. Any remaining sediment in the secondary core was discarded as per SOP 9 — Core Processing and SOP 11 — Management and Disposal of Residuals. Sample intervals were marked on the outside of the primary core tube and cores were placed horizontally on the processing table. Cores were split longitudinally using electric shears and stainless steel spatulas. VOC and percent moisture samples were collected immediately following core splitting. Following collection of those samples, cores were described lithologically and photologged. For cores requiring only chemical analysis, sediment was then transferred to stainless steel bowls for homogenization and sampling.

Cores requiring both chemical and radiochemical analyses were processed similar to those requiring only chemical analysis, in that the 0- to 0.5-foot segment was processed in accordance with the procedure for high-water-content sediments. Marks were then made on the outside of the core tube at 2, 4 and 6 inches from the top of sediment (adjusted based on core percent recovery). Sediment was removed in 2-inch increments, to satisfy radiochemistry sampling requirements. VOC, AVS/SEM and percent moisture samples were collected from undisturbed sediments in the 0- to 0.5-foot interval of the secondary core.

Following VOC, AVS/SEM and percent moisture sampling, the remaining sediment was transferred to stainless steel bowls for lithological description, photologging and homogenization prior to further sampling.

Samples were collected from the predetermined intervals presented in Tables 6-2 and 6-3 of the approved HRSA RIWP (BBL, 2005a), with the exception of those cores where clay was encountered along sampling intervals, preventing sample collection.

In addition to those samples that could not be collected from core location 033, samples were not collected as prescribed in the approved HRSA RIWP (BBL, 2005a) for the following cores due to the presence of clay:

- 001: 2- to 4-foot interval
- 009: 0.5- to 2-foot interval
- 033: 0- to 0.5-, 0.5- to 2-, and 2- to 4-foot intervals
- 035: 2- to 4-foot interval

Where both clay and non-clay sediments were recovered in a sample interval, only non-clay sediments were obtained for analysis. In these instances of potentially limited available sample mass, the chemical analysis hierarchal prioritization was followed, as presented in Table 6-6 of the approved HRSA RIWP (BBL, 2005a). Other than for the six samples listed above, no additional analyses were missed due to sample mass issues.

Samples for Be-7 analysis were collected from the grab sampler and placed directly in laboratory jars on the coring vessels.

3.1.6 Sample Handling, Preservation and Shipment to Laboratories

Samples were handled, preserved and shipped to laboratories in accordance with SOP No. 2 — Containers, Preservation, Handling and Tracking of Samples for Analysis. Following collection of sediment in the respective sample jars, jar lids were secured and wrapped with tape and jar labels were sealed with clear tape. Sample jars were then placed in appropriately sized bubble-wrap baggies, and sealed within zip-lock baggies. Packed jars were placed in padded coolers with ice and sealed prior to shipment to the appropriate laboratories. Trip blanks were placed in coolers where required, as per SOP No. 2 — Containers, Preservation, Handling and Tracking of Samples for Analysis.

Sample containers were received undamaged by the laboratories, with the following exceptions:

- the jar holding sample 019B-05 was found to be damaged upon receipt at STL
- the lid of the jar holding sample 013B-02 was found to be damaged upon receipt at Alta
- the jar holding sample 038A-01 was found to be damaged upon receipt by Alta

Based upon a review of photographs of the damaged lid and containers, it was not deemed necessary by ESI to recollect the samples. In each case, the sample material was salvaged and analyzed in accordance with the appropriate analytical procedures.

Samples were shipped and received at the laboratories within 24 hours of collection, with the exception of one shipment. The October 25, 2006 sample shipment to STL, scheduled to arrive on October 26, 2006, was improperly sorted by the United Parcel Service (UPS) and did not arrive at STL until October 27, 2006. Samples designated for analysis by STL were received within the preservation and analysis holding times, with the exception of the following samples designated for VOC analysis:

In-River Samples:

- 003C-01, 003C-02 (including DUP002A) and 003C-03
- 004B-01 and 004B-02

Mudflat Samples:

- 043A-01
- 044A-01
- 045A-01
- 046A-01
- 047A-01

To prevent biased low concentration estimates, samples designated for VOC analysis must be preserved by the laboratory within 48 hours of sample collection. The longest time that samples were held from the late shipment prior to preservation was 51 hours

and 40 minutes from the time of collection. The quantitative impact expected from this marginal exceedance of 48 hours is minimal, and as such, samples did undergo VOC analysis. Analytical results for VOC samples that exceeded the 48-hour holding time are flagged "J," as estimated values.

3.1.7 Laboratory Analysis

Laboratory analyses were conducted on sediment samples for chemical, radiochemical and geotechnical characterization, in accordance with the analytical program outlined in the approved HRSA RIWP (BBL, 2005a).

3.1.7.1 Chemical Characterization

Samples collected for chemical characterization of HRSA sediments were analyzed for the following chemical groups:

- pesticides and Aroclor PCBs
- SVOCs
- VOCs
- TAL metals (including mercury)
- total cyanide
- AVS/SEM (Ag, Cd, Cu, Pb, Hg, Ni and Zn only)
- hexavalent chromium
- congener PCBs and homologues
- chlorinated herbicides
- PCDDs and PCDFs

- TEPH
- TOC
- pH
- ORP

Details regarding the specific extraction and analytical methods conducted are described in Section 6.4 of the approved HRSA RIWP (BBL, 2005a). Minor modifications to the analytical program were outlined in the aforementioned PRG letter to the NJDEP dated October 18, 2006.

Chemical analytical results are summarized in Section 4.

3.1.7.2 Radiochemical Characterization

Samples collected for radiochemical characterization were analyzed for the following parameters:

- Be-7
- Lead-210 (Pb-210)
- Cesium-137 (Cs-137)

Details regarding the specific extraction and analytical methods conducted are described in Section 6.4 of the approved HRSA RIWP (BBL, 2005a).

Radiochemical results are summarized in Section 4.

3.1.7.3 Physical Characterization

Physical characterization information was obtained from visual lithologic descriptions recorded on core lithology forms and samples collected for grain-size analysis. Core lithology information and grain-size distribution samples were collected in accordance with SOP No. 9 — Core Processing.

Core lithology records are included as Appendix C. Results from samples collected for geotechnical characterization are summarized in Section 4.

3.2 Data Management

In accordance with SOP No. 1 — Field Documentation, pertinent field data, including weather conditions, air temperature, field personnel, field equipment, field equipment calibration, sample collection, coordinates and processing, were recorded in the daily logbooks and field forms. To the extent possible, field data and forms were transferred to the electronic field database for data reduction and efficient management.

3.2.1 Sample Identification and Tracking

Samples were identified and tracked using the nomenclature conventions and procedures described in SOP No. 2 — Containers, Preservation, Handling and Tracking of Samples for Analysis. Proper custody procedures were followed, with shipping receipts acting as documentation of custody during sample shipment.

Upon receipt, laboratory personnel inspected samples for integrity, agreement with chain of custody forms and for evidence of tampering during shipment. Laboratory personnel also verified that the temperature of the shipping containers, upon arrival at the laboratory, did not exceed 4 $^{\circ}$C. Laboratory internal chain of custody procedures were followed as outlined in the approved HRSA RIWP (BBL, 2005a).

3.2.2 Database

Analytical results were obtained from laboratories in electronic and hard copy format. Data were validated in accordance with the validation program outlined in Section 3.3. Validated project data were transferred to the project database, after which a 10 percent accuracy check was performed by ARCADIS BBL to optimize data accuracy. The project database is being maintained consistent with the procedures prescribed in the approved HRSA RIWP (BBL, 2005a).

3.3 Data Validation Program

Data validation was performed on 100 percent of the analytical data, in accordance with Section 8.1.2 of the approved HRSA RIWP (BBL, 2005a). Data validation provides a mechanism by which to measure data quality, determine if data quality objectives (DQOs) are met, identify usable and unusable data, assess laboratory performance

and aid in making informed decisions regarding the data set. An overview of the data validation procedures is presented below.

3.3.1 Data Validation Procedures

Data validation included an evaluation of documented quality assurance/quality control (QA/QC) measures through a review of tabulated QC summary forms and raw instrument data. Specifically, the validation was based on a review of:

- sample holding times
- sample condition upon laboratory receipt
- gas chromatogram/mass spectrometry (GC/MS) tuning and system performance
- calibration and calibration verification
- blank analysis results
- surrogate recoveries
- internal standard recoveries
- matrix spike/matrix spike duplicate (MS/MSD) recoveries and precision
- laboratory control sample/laboratory control sample duplicate (LCS/LCSD) recoveries and precision
- field duplicate precision
- ongoing precision and recovery (OPR) standard results
- ion abundance ratios
- retention times (RTs)
- signal-to-noise (S/N) ratios

- inductively coupled plasma (ICP) interference check sample results, serial dilution results and linear range
- analytical sequence
- qualitative identification
- quantitation of results
- critical evaluation of instrumental raw data

The analytical results were submitted to ESI by the laboratories in electronic format and loaded into the project database. The data validator then compared the electronic results against the hardcopy laboratory data packages to provide accuracy and consistency between the electronic and hardcopy results.

Data validation was performed with guidance from the *National Functional Guidelines for Organic Data Review* (USEPA, 1999), *National Functional Guidelines for Inorganic Data Review* (USEPA, 2002) and the USEPA Region II method-specific SOPs listed in Section 8.1.2 of the approved HRSA RIWP (BBL, 2005a).

Validation qualifier codes were placed next to the analytical results in the project database so the data users can quickly assess the qualitative and/or quantitative reliability of any result. The qualifier codes and definitions used for the data are as follows:

- "Null" — No qualifier code. The compound was detected and should be considered quantitatively and qualitatively valid based on the QC reviewed.
- U — Nondetect. The analyte was analyzed for, but was not detected above the reported method detection limit (MDL) (or estimated detection limit [EDL]) or was present in a blank at a similar concentration.
- J — Estimated value. The analyte was positively identified, but the associated numerical value is the approximate concentration of the analyte in the sample.
- JL — The reported result is a biased low approximate concentration of the analyte in the sample.

- JH — The reported result is a biased high approximate concentration of the analyte in the sample.

- NJ — The analysis indicates the presence of an analyte that has been "tentatively identified" and the associated numerical value represents its approximate concentration.

- UJ — Estimated nondetect. The analyte was not detected above the reported MDL (or EDL). The associated quantitation limit is an estimate and may be inaccurate or imprecise.

- UL — The analyte was not detected and the quantitation limit is probably higher than reported.

- R — The sample results are rejected. Due to significant QA/QC problems, the analysis is invalid and provides no information as to whether the analyte is present or not.

- Estimated maximum possible concentration (EMPC) — Chromatographic peaks are present in the expected retention time window; however, the peaks do not meet all of the conditions required for positive identification. The reported result represents the estimated maximum possible concentration if the analyte was present.

- G — The reported organic result is below the sample quantitation limit (SQL) but above the MDL (or EDL).

- M — The analytical result reported was obtained from a sediment sample found to contain between 50 percent and 90 percent moisture, and had no other data qualifiers added during the data validation process.

3.3.2 Dioxin/Furan Performance Evaluation Results

Two single-blind performance evaluation (PE) samples, one known to contain elevated levels of dioxins/furans and one containing trace levels to simulate a clean sample, were submitted to Alta on August 10, 2006. The PE samples were obtained from Cambridge Isotope Laboratories and were submitted to meet the PE requirement specified in Section 6.5.2.6 of the approved HRSA RIWP (BBL, 2005a). These samples were analyzed for PCDD/PCDF according to USEPA Method 1613B. Certified values and

reference ranges were provided by Cambridge Isotope Laboratories for all analytes of interest in the PE samples. The majority of the results for the PE samples were within the specified limits. Exceptions are detailed in the PE sample data validation report (presented in Appendix F as introduced later in this RI Report). As a whole, the PE sample results were acceptable and the minor number of outliers did not present significant data quality concerns.

4. Remedial Investigation Data Summary

As discussed in Section 3, the HRSA RI Program consisted of collecting and analyzing 199 sediment samples for a variety of chemical, radiochemical and physical parameters. Sample collection and laboratory analyses were performed in accordance with the SOPs provided in the approved HRSA RIWP (BBL, 2005a). The QA/QC activities performed on HRSA data are summarized in Section 3.3.

This section provides a broad overview of the sediment sampling results, both by chemical class and individual constituent. Individual constituents chosen for discussion include those identified as regional COIs.

For data presentation and analysis purposes, field and duplicate sample results were averaged together to create one result. In addition, results discussed in this section only focus on detected concentrations.

For reference purposes, visual lithologic descriptions are provided in Appendix C, analytical results are provided in Appendix D and statistical summaries are provided in Appendix E. As referenced throughout the data discussions, Appendix E provides summary statistics for each chemical class, including arithmetic mean, median, minimum, maximum, standard deviation and geometric mean. Appendix E also summarizes the data by sampling area (i.e., in-River versus Mudflat) and depth.

4.1 Chemical Analyses

4.1.1 VOCs

A total of 124 samples (105 in-River and 19 Mudflat) were analyzed for VOCs as part of the HRSA RI Program. VOCs were measured in accordance with USEPA Method 8260, which employs purge-and-trap with analysis by high-resolution gas chromatography/low-resolution mass spectrometry (HRGC/LRMS). Table D-1 of Appendix D presents individual sample results, while summary statistics for in-River and Mudflat samples (by depth) are presented in Appendix E.

As shown in Appendix E, VOCs were mostly undetected in sediments, as 24 of the 33 constituents were not found. Acetone was detected at the highest frequency (51 percent). The next four highest frequencies of detected concentrations were 2-butanone (40 percent), toluene (17 percent), carbon disulfide (14 percent) and xylenes (total) (11 percent). Regional COIs, including BTEX, are discussed further below.

These discussions are supported by the above-referenced appendices, Figure 3-1 (which depicts the final coring locations) and Table 4-1 (which provides summary statistics).

4.1.1.1 Benzene

Overall, benzene was detected in 10 percent of all samples, 4 percent of all surface samples (i.e., 0 to 0.5 feet) and 16 percent of all subsurface samples (i.e., deeper than 0.5 feet). Detected concentrations ranged from 3.3 micrograms per kilogram (µg/kg) to 1,800 µg/kg, with the maximum detected concentration observed within the 0.5- to 2-foot interval at location 008 (Figure 3-1).

The following paragraphs discuss additional details associated with both in-River and Mudflat samples.

In-River Samples (Benzene)

Benzene was detected in surface samples (0- to 0.5-foot interval) at a frequency of 5 percent. Detected concentrations ranged from 14 µg/kg to 1,300 µg/kg, with the maximum detection observed in core 008.

At the 0.5- to 2-foot and 2- to 4-foot intervals, benzene was detected collectively at a frequency of 13 percent, with detected concentrations ranging from 3.3 µg/kg to 1,800 µg/kg. The maximum benzene detection was observed in the 0.5- to 2-foot interval in core 008.

Finally, benzene was detected in 33 percent of the samples collected at depths greater than 4 feet. Concentrations at this depth ranged from 3.4 µg/kg to 12 µg/kg, with the maximum observed in the 8- to 10-foot interval in core 005.

As shown in Table 4-1, the highest mean detected concentration of benzene (657 µg/kg) was observed in the 0- to 0.5-foot sampling interval. The next highest mean detected concentration (528 µg/kg) occurred at the 0.5- to 2-foot sampling interval.

Mudflat Samples (Benzene)

Benzene was not detected in Mudflat samples.

4.1.1.2 Toluene

Overall, toluene was detected in 17 percent of all samples, 18 percent of all surface samples (i.e., 0 to 0.5 feet) and 16 percent of all subsurface samples (i.e., deeper than 0.5 feet). Detected concentrations ranged from 0.89 µg/kg to 1,400 µg/kg, with the maximum detected concentration observed in core 012 (Figure 3-1).

The following paragraphs discuss additional details associated with detections of toluene in both in-River and Mudflat samples.

In-River Samples (Toluene)

Toluene was detected in surface samples (0 to 0.5 feet) at a frequency of 24 percent. Detected concentrations ranged from 1.8 µg/kg to 23 µg/kg, with the maximum detection observed in core 012.

At the 0.5- to 2-foot and 2- to 4-foot intervals, toluene was detected collectively at a frequency of 14 percent, with detected concentrations ranging from 0.89 µg/kg to 1,400 µg/kg. The maximum toluene detection was observed in the 0.5- to 2-foot interval in core 012.

Finally, toluene was detected in 25 percent of samples collected at depths greater than 4 feet. Concentrations at this depth ranged from 2.5 µg/kg to 16 µg/kg, with the maximum detection observed in the 8- to 10-foot interval in core 005.

The highest mean detected concentration for toluene (253 µg/kg) was observed in the 2- to 4-foot interval. The next highest mean detected concentration (239 µg/kg) was observed in the 0.5- to 2-foot interval.

Mudflat Samples (Toluene)

Toluene was detected in only one sample, collected from Mudflat 1, at a concentration of 2.2 µg/kg.

4.1.1.3 Ethylbenzene

Overall, ethylbenzene was detected in 10 percent of all samples, 7 percent of all surface samples (i.e., 0 to 0.5 feet) and 13 percent of subsurface samples (i.e., deeper

than 0.5 feet). Detected concentrations ranged from 3.8 µg/kg to 8,600 µg/kg, with the maximum detected concentration observed in core 011 (Figure 3-1).

The following paragraphs discuss additional details associated with ethylbenzene detections in both in-River and Mudflat samples.

In-River Samples (Ethylbenzene)

Ethylbenzene was detected in surface samples (0 to 0.5 feet) at a frequency of 11 percent. Detected concentrations ranged from 3.8 µg/kg to 5,300 µg/kg, with the maximum detection observed in core 008.

At the 0.5- to 2-foot and 2- to 4-foot intervals, ethylbenzene was detected collectively at a frequency of 11 percent, with detected concentrations ranging from 110 µg/kg to 8,600 µg/kg. The maximum ethylbenzene detection in these sampling intervals was observed in the 2- to 4-foot interval in core 011.

Finally, ethylbenzene was detected in 25 percent of samples collected at depths greater than 4 feet. Concentrations at these depths ranged from 27 µg/kg to 110 µg/kg, with the maximum detection observed in the 8- to 10-foot interval in core 010.

The highest mean detected concentration for ethylbenzene (4,540 µg/kg) was observed in the 2- to 4-foot sampling interval. The next highest mean detected concentration (1,620 µg/kg) was observed in the 0.5- to 2-foot sampling interval.

Mudflat Samples (Ethylbenzene)

Ethylbenzene was not detected in Mudflat samples.

4.1.1.4 Xylene

Overall, xylene was detected in 11 percent of all samples, 5 percent of all surface samples (i.e., 0 to 0.5 feet) and 16 percent of all subsurface samples (i.e., deeper than 0.5 feet). Detected concentrations ranged from 13 µg/kg to 12,000 µg/kg, with the maximum detected concentration observed in the 0.5- to 2-foot interval at location 012 (Figure 3-1).

The following paragraphs discuss additional details associated with xylene detections in both in-River and Mudflat samples.

In-River Samples (Xylene)

Xylene was detected in surface samples (0 to 0.5 feet) at a frequency of 8 percent. Detected concentrations ranged from 15 µg/kg to 200 µg/kg, with the maximum detection observed in core 008.

At the 0.5- to 2-foot and 2- to 4-foot intervals, xylene was detected collectively at a frequency of 13 percent, with detected concentrations ranging from 22 µg/kg to 12,000 µg/kg. The maximum xylene concentration was observed in the 0.5- to 2-foot interval in core 012.

Finally, xylene was detected in 33 percent of samples collected at depths greater than 4 feet. Detected concentrations ranged from 13 µg/kg to 130 µg/kg, with the maximum detection observed in the 8- to 10-foot interval in core 005.

The highest mean detected concentration for xylene (3,500 µg/kg) was observed in the 2- to 4-foot interval. The next highest concentration (3,120 µg/kg) was observed in the 0.5- to 2-foot interval.

Mudflat Samples (Xylene)

Xylene was not detected in Mudflat samples.

4.1.2 SVOCs

A total of 124 samples (105 in-River and 19 Mudflat) were analyzed for SVOCs as part of the HRSA RI Program. SVOCs were measured in accordance with USEPA Method SW-846 3541/8270C using a GC/MS. Table D-2 of Appendix D presents individual sample results; summary statistics for in-River and Mudflat samples (by depth) are presented in Appendix E.

As shown in Appendix E, 32 of the 67 SVOC parameters analyzed were not detected in HRSA sediment. Of the 64 individual SVOCs analyzed, 39 percent were detected in HRSA samples at frequencies greater than 10 percent. The majority of these detected analytes were PAHs. As a whole, total PAHs were detected in 77 percent of all HRSA samples.

The five SVOCs detected at the highest frequencies were fluoranthene (75 percent), benzo(a)anthracene (74 percent), chrysene (74 percent), pyrene (71 percent) and

phenonthrene and benzo(a)pyrene (73 percent each). SVOCs identified as regional COIs include naphthalene (59 percent); 1,4-dichlorobenzene (1,4-DCB) (32 percent); 1,2,4-trichlorobenzene (1,2,4-TCB) (16 percent); 1,3-dichlorobenzene (1,3-DCB) (15 percent); and 1,2-dichlorobenzene (1,2-DCB) (12 percent).

The following subsections provide a more detailed discussion of the six regional COIs identified above (including total PAHs). These discussions are supported by Appendices D and E, Figure 3-1 (which depicts final coring locations), and Table 4-2 (which provides summary statistics).

Due to high detections of some individual PAHs, dilutions were performed on most SVOC samples. As a result, SQLs for nondetect results were significantly higher than those prescribed in the approved HRSA RIWP (BBL, 2005a). The SVOC subsections below (and in Section 5) discuss detected concentrations only.

4.1.2.1 1,2-Dichlorobenzene

Overall, 1,2-DCB was detected in 12 percent of all samples, 25 percent of all surface samples (i.e., 0 to 0.5 feet), and 1 percent of all subsurface samples (i.e., deeper than 0.5 feet). Detected concentrations ranged from 10 µg/kg to 640 µg/kg, with the maximum detected concentration observed in the 0- to 0.5-foot interval at location 037 (Figure 3-1).

The following paragraphs discuss additional details associated with 1,2-DCB detections in both in-River and Mudflat samples.

In-River Samples (1,2-Dichlorobenzene)

1,2-DCB was detected in surface samples (0 to 0.5 feet) at a frequency of 16 percent. Detected concentrations ranged from 11 µg/kg to 640 µg/kg, with the maximum detection observed along Transect 24 in core 037.

At the 0.5- to 2-foot interval, 1,2-DCB was detected in only one sample. The single detect (47 µg/kg) was observed in core 031. 1,2-DCB was not detected at depths greater than 2 feet.

The highest mean detected concentration for 1,2-DCB (143 µg/kg) was observed in the 0- to 0.5-foot interval. The next highest mean detected concentration (47 µg/kg) was observed in the 0.5- to 2-foot interval.

Mudflat Samples (1,2-Dichlorobenzene)

1,2-DCB was detected in Mudflat samples at a frequency of 42 percent. Detected concentrations ranged from 10 µg/kg to 53 µg/kg, with the maximum detection observed in Mudflat 9.

The highest mean detected concentration for 1,2-DCB (33.5 µg/kg) was observed in Mudflat 2, followed by Mudflat 4 (21.5 µg/kg).

4.1.2.2 1,3-Dichlorobenzene

Overall, 1,3-DCB was detected in 15 percent of all samples, 27 percent of all surface samples (i.e., 0 to 0.5 feet) and 6 percent of all subsurface samples (i.e., deeper than 0.5 feet). Detected concentrations ranged from 7.7 µg/kg to 2,700 µg/kg, with the maximum detected concentration observed in the 0- to 0.5-foot interval at location 037 (Figure 3-1).

The following paragraphs discuss additional details associated with 1,3-DCB detections in both in-River and Mudflat samples.

In-River Samples (1,3-Dichlorobenzene)

1,3-DCB was detected in surface samples (0- to 0.5-foot interval) at a frequency of 24 percent. Detected concentrations ranged from 7.7 µg/kg to 2,700 µg/kg, with the maximum detection observed in core 037.

At the 0.5- to 2-foot interval, 1,3-DCB was detected in only four samples. These samples were collected from cores 002, 013, 030 and 031. Detected concentrations ranged from 8.3 µg/kg to 530 µg/kg, with the maximum detected concentration observed in core 030. 1,3-DCB was not detected at depths greater than 2 feet.

The highest mean detected concentration for 1,3-DCB (405 µg/kg) was observed in the 0- to 0.5-foot interval. The next highest mean detected concentration (160 µg/kg) was observed in the 0.5- to 2-foot interval.

Mudflat Samples (1,3-Dichlorobenzene)

1,3-DCB was detected in Mudflat samples at a frequency of 32 percent, with detected concentrations ranging from 16 µg/kg to 72 µg/kg. The maximum detected concentration was observed in Mudflat 10.

The highest mean detected concentration for 1,3-DCB (72 µg/kg) was observed in Mudflat 10, followed by Mudflat 9 (59 µg/kg).

4.1.2.3 1,4-Dichlorobenzene

Overall, 1,4-DCB was detected in 32 percent of all samples, 54 percent of all surface samples (i.e., 0 to 0.5 feet) and 15 percent of all subsurface samples (i.e., deeper than 0.5 feet). Detected concentrations ranged from 9.4 µg/kg to 8,500 µg/kg, with the maximum detected concentration observed in the 0- to 0.5-foot interval at location 037 (Figure 3-1).

The following paragraphs discuss additional details associated with detections of 1,4-DCB in both in-River and Mudflat samples.

In-River Samples (1,4-Dichlorobenzene)

1,4-DCB was detected in surface samples (0- to 0.5-foot interval) at a frequency of 43 percent. Detected concentrations ranged from 14 µg/kg to 8,500 µg/kg, with the maximum detection observed in core 037.

1,4-DCB was detected in the 0.5- to 2-foot and 2- to 4-foot intervals at a frequency of 18 percent. Detected concentrations ranged from 9.4 µg/kg to 1,400 µg/kg, with the maximum detection observed in the 0.5- to 2-foot interval in core 030. 1,4-DCB was not detected in samples collected at depths greater than 4 feet.

The highest mean detected concentration for 1,4-DCB (939 µg/kg) was observed in the 0- to 0.5-foot interval. The next highest mean detected concentration (259 µg/kg) was observed in the 0.5- to 2-foot interval.

Mudflat Samples (1,4-Dichlorobenzene)

1,4-DCB was detected in Mudflat samples at a frequency of 74 percent, with detected concentrations ranging from 18 µg/kg to 270 µg/kg. The maximum detected concentration for Mudflat samples was observed in Mudflat 10.

The highest mean detected concentration for 1,4-DCB (220 µg/kg) was observed in Mudflat 10, followed by Mudflat 9 (210 µg/kg).

4.1.2.4 1,2,4-Trichlorobenzene

Overall, 1,2,4-TCB was detected in 16 percent of all samples, 32 percent of all surface samples (i.e., 0 to 0.5 feet) and 3 percent of all subsurface samples (i.e., deeper than 0.5 feet). Detected concentrations ranged from 23 µg/kg to 5,600 µg/kg, with the maximum detected concentration observed in the 0- to 0.5-foot interval at location 037 (Figure 3-1).

The following paragraphs discuss additional details associated with detections of 1,2,4-TCB in both in-River and Mudflat samples.

In-River Samples (1,2,4-Trichlorobenzene)

1,2,4-TCB was detected in surface samples (0- to 0.5-foot interval) at a frequency of 27 percent. Detected concentrations ranged from 61 µg/kg to 5,600 µg/kg, with the maximum detection observed in core 037.

At the 0.5- to 2-foot interval, 1,2,4-TCB was detected in only two samples. The samples were collected from cores 030 and 031, with detected concentrations ranging from 210 µg/kg to 880 µg/kg. The maximum 1,2,4-TCB detection in this interval was observed in core 030. 1,2,4-TCB was not detected in samples collected at depths greater than 2 feet.

The highest mean detected concentration for 1,2,4-TCB (1,350 µg/kg) was observed in the 0- to 0.5-foot interval. The next highest mean detected concentration (545 µg/kg) was observed in the 0.5- to 2-foot interval.

Mudflat Samples (1,2,4-Trichlorobenzene)

1,2,4-TCB was detected in Mudflat samples at a frequency of 42 percent, with detected concentrations ranging from 23 µg/kg to 120 µg/kg. The maximum detected concentration for Mudflat samples was observed on Mudflat 9.

The highest mean detected concentration for 1,2,4-TCB (120 µg/kg) was observed in Mudflat 9, followed by Mudflat 2 (110 µg/kg).

4.1.2.5 Naphthalene

Overall, naphthalene was detected in 59 percent of all samples, 80 percent of all surface samples (i.e., 0 to 0.5 feet) and 41 percent of all subsurface samples (i.e., deeper than 0.5 feet). Detected concentrations ranged from 14 µg/kg to 11,000,000 µg/kg, with the maximum detected concentration observed in the 0.5- to 2-feet interval at location 012 (Figure 3-1).

The following paragraphs discuss additional details associated with naphthalene detections in both in-River and Mudflat samples.

In-River Samples (Naphthalene)

Naphthalene was detected in surface samples (0 to 0.5 feet) at a frequency of 84 percent. Detected concentrations ranged from 29 µg/kg to 3,200,000 µg/kg, with the maximum detection observed in core 012.

At the 0.5- to 2-foot and 2- to 4-foot intervals, naphthalene was detected collectively at a frequency of 43 percent, with detected concentrations ranging from 14 µg/kg to 11,000,000 µg/kg and the maximum detection observed in the 0.5- to 2-foot interval in core 012.

Finally, naphthalene was detected in 33 percent of samples collected at depths greater than 4 feet. Detected concentrations at this depth ranged from 26 µg/kg to 250,000 µg/kg, with the maximum detection observed in the 8- to 10-foot interval in core 005.

The highest mean detected concentration for naphthalene (666,000 µg/kg) was observed in the 0.5- to 2-foot sampling interval. The next highest mean detected concentration (430,000 µg/kg) was observed in the 8- to 10-foot interval.

Mudflat Samples (Naphthalene)

Naphthalene was detected in Mudflat samples at a frequency of 74 percent, with detected concentrations ranging from 39 µg/kg to 1,200 µg/kg. The maximum detection was observed in Mudflat 2.

The highest mean detected concentration for naphthalene (1,040 µg/kg) was observed in Mudflat 2, followed by Mudflat 4 (550 µg/kg).

4.1.2.6 Total PAHs

Overall, total PAHs were detected in 77 percent of all samples, 100 percent of all surface samples (i.e., 0 to 0.5 feet) and 57 percent of all subsurface samples (i.e., deeper than 0.5 feet). Detected concentrations ranged from 13 µg/kg to 75,300,000 µg/kg, with the maximum detected concentration observed in the 0.5- to 2-foot interval at location 01 (Figure 3-1).

The following paragraphs discuss additional details associated with total PAH detections in both in-River and Mudflat samples.

In-River Samples (Total PAHs)

Total PAHs were detected in surface samples (0 to 0.5 feet) at a frequency of 100 percent. Detected concentrations ranged from 98 µg/kg to 56,800,000 µg/kg, with the maximum observed in core 012.

At the 0.5- to 2-foot and 2- to 4-foot intervals, total PAHs were detected collectively at a frequency of 63 percent, with detected concentrations ranging from 13 µg/kg to 75,300,000 µg/kg. The maximum detection of total PAHs was observed in the 0.5- to 2-foot interval in core 012.

Finally, total PAHs were detected in 33 percent of samples collected at depths greater than 4 feet. Concentrations at this depth ranged from 236,000 µg/kg to 708,000 µg/kg, with the maximum detection observed in the 8- to 10-foot interval in core 005.

The highest mean detected concentration for total PAHs (3,210,000 µg/kg) was observed in the 0.5- to 2-foot sampling interval. The next highest mean detected concentration (1,680,000 µg/kg) was observed in the 0- to 0.5-foot interval.

Mudflat Samples (Total PAHs)

Total PAHs were detected in Mudflat samples at a frequency of 100 percent, with detected concentrations ranging from 0.24 µg/kg to 47 µg/kg. The maximum detected concentration was observed in Mudflat 10.

The highest mean detected concentration of total PAHs (34,500 µg/kg) was observed in Mudflat 2, followed by Mudflat 4 (32,700 µg/kg).

4.1.3 Inorganics

A total of 124 samples (105 in-River and 19 Mudflat) were analyzed for inorganics as part of the HRSA RI Program. TAL metals were measured in accordance with USEPA Method SW-846 3050/ 6010B using an inductively coupled plasma mass spectroscopy (ICPMS). Hexavalent chromium analyses were performed in accordance with USEPA Method SW-846 3060A/7199 using ion chromatography/colorimetric and mercury analyses were performed in accordance with USEPA Method SW-846 INC/7471A using cold vapor atomic absorption. Table D-3 of Appendix D presents individual sample results, while summary statistics for in-River and Mudflat samples (by depth) are presented in Appendix E.

As shown in Appendix E, inorganics were detected in most sediment samples collected. Several constituents were detected in 100 percent of sediment samples, including aluminum, arsenic, barium, calcium, total chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, sodium and vanadium.

The following subsections provide a more detailed discussion of regional COIs, including total chromium, hexavalent chromium, total cyanide, lead and mercury. These discussions are supported by Appendices D and E, Figure 3-1 (which depicts the final coring locations) and Table 4-3 (which provides summary statistics).

4.1.3.1 Total Chromium

Overall, total chromium was detected in 100 percent of all samples. Detected concentrations ranged from 5.5 milligrams per kilogram (mg/kg) to 1,170 mg/kg, with the maximum detected concentration observed in the 0.5- to 2-foot interval at location 005 (Figure 3-1).

The following paragraphs discuss additional details associated with total chromium detections in both in-River and Mudflat samples.

In-River Samples (Total Chromium)

Total chromium was detected in surface samples (0 to 0.5 feet) at a frequency of 100 percent. Detected concentrations ranged from 6.5 mg/kg to 480 mg/kg, with the maximum detection observed in core 006.

At the 0.5- to 2-foot and 2- to 4-foot intervals, total chromium was detected collectively at a frequency of 100 percent, with detected concentrations ranging from 5.5 mg/kg to 1,170 mg/kg. The maximum total chromium detection was observed in the 0.5- to 2-foot interval in core 005.

Finally, total chromium was detected in 100 percent of samples collected at depths greater than 4 feet. Concentrations at this depth ranged from 20.7 mg/kg to 254 mg/kg, with the maximum detection observed in the 4- to 6-foot interval in core 005.

The highest mean detected concentration for total chromium (110 mg/kg) was observed in the 2- to 4-foot interval. The next highest mean detected concentration (107 mg/kg) was observed in the 0.5- to 2-foot interval.

Mudflat Samples (Total Chromium)

Total chromium was detected in Mudflat samples at a frequency of 100 percent, with detected concentrations ranging from 23.5 mg/kg to 196 mg/kg. The maximum detected concentration was observed in Mudflat 2.

The highest mean detected concentration for total chromium (145 mg/kg) was observed in Mudflat 2, followed by Mudflat 6 (134 mg/kg).

4.1.3.2 Hexavalent Chromium

Overall, hexavalent chromium was detected in 43 percent of all samples, 45 percent of all surface samples (i.e., 0 to 0.5 feet) and 41 percent of all subsurface samples (i.e., deeper than 0.5 feet). Detected concentrations ranged from 0.34 mg/kg to 19.7 mg/kg, with the maximum detected concentration observed in the 0- to 0.5-foot interval at location 005 (Figure 3-1).

The following paragraphs discuss additional details associated with both in-River and Mudflat samples.

In-River Samples (Hexavalent Chromium)

Hexavalent chromium was detected in surface samples (0 to 0.5 feet) at a frequency of 51 percent, with detected concentrations ranging from 0.36 mg/kg to 19.7 mg/kg and the maximum detection observed in core 005.

At the 0.5- to 2-foot and 2- to 4-foot intervals, hexavalent chromium was detected collectively at a frequency of 38 percent, with detected concentrations ranging from 0.34 mg/kg to 13.2 mg/kg. The maximum hexavalent chromium detection was observed in the 0.5- to 2-foot interval in core 005.

Finally, hexavalent chromium was detected in 58 percent of samples collected at depths greater than 4 feet. Detected concentrations at this depth ranged from 0.41 mg/kg to 2.1 mg/kg, with the maximum detection observed in the 4- to 6-foot interval in core 005.

The highest mean detected concentration for hexavalent chromium (12.9 mg/kg) was observed in the 4- to 6-foot interval. The next highest mean detected concentration (2.76 mg/kg) was observed in the 0.5- to 2-foot interval.

Mudflat Samples (Hexavalent Chromium)

Hexavalent chromium was detected in Mudflat samples at a frequency of 32 percent, with detections ranging from 0.79 mg/kg to 8.1 mg/kg. The maximum hexavalent chromium detection for Mudflat samples was observed in Mudflat 4.

The highest mean detected concentration for hexavalent chromium (7.15 mg/kg) was observed in Mudflat 4, followed by Mudflat 6 (2.83 mg/kg).

4.1.3.3 Total Cyanide

Overall, total cyanide was detected in 15 percent of all samples, 18 percent of all surface samples (i.e., 0 to 0.5 feet) and 12 percent of all subsurface samples (i.e., deeper than 0.5 feet). Detected concentrations ranged from 0.33 mg/kg to 8.3 mg/kg, with the maximum detected concentration observed in the 0- to 0.5-foot interval at location 012 (Figure 3-1).

The following paragraphs discuss additional details associated with total cyanide detections in both in-River and Mudflat samples.

In-River Samples (Total Cyanide)

Total cyanide was detected in surface samples (0 to 0.5 feet) at a frequency of 16 percent. Detected concentrations ranged from 0.33 mg/kg to 8.3 mg/kg, with the maximum detection observed in core 012.

At the 0.5- to 2-foot and 2- to 4-foot intervals, total cyanide was detected collectively at a frequency of 14 percent, with detected concentrations ranging from 0.49 mg/kg to 8 mg/kg. The maximum total cyanide detection was observed in the 0.5- to 2-foot interval in core 031. Cyanide was not detected in samples collected at depths greater than 4 feet.

The highest mean detected concentration for total cyanide (2.15 mg/kg) was observed in the 0.5- to 2-foot interval. The next highest mean detected concentration (1.89 mg/kg) was observed in the 0- to 0.5-foot interval.

Mudflat Samples (Total Cyanide)

Total cyanide was detected in Mudflat samples at a frequency of 21 percent, with detected concentrations ranging from 0.64 mg/kg to 7.1 mg/kg. The maximum detected concentration for Mudflat samples was observed in Mudflat 1.

The highest mean detected concentration for total cyanide (7.1 mg/kg) was observed in Mudflat 1, followed by Mudflat 6 (2.07 mg/kg).

4.1.3.4 Lead

Overall, lead was detected in 100 percent of all samples. Detected concentrations ranged from 0.045 mg/kg to 709 mg/kg, with the maximum detected concentration observed in the 0- to 0.5-foot interval at location 008 (Figure 3-1).

The following paragraphs discuss additional details associated with lead detections in both in-River and Mudflat samples.

In-River Samples (Lead)

Lead was detected in surface samples (0 to 0.5 ft) at a frequency of 100 percent. Detected concentrations ranged from 0.045 mg/kg to 709 mg/kg, with the maximum detection observed along Transect 7 in core 008.

At the 0.5- to 2-foot and 2- to 4-foot intervals, lead was detected collectively at a frequency of 100 percent, with detected concentrations ranging from 1.9 mg/kg to 555 mg/kg. The maximum lead detection was observed in the 0.5- to 2-foot interval in core 006.

Finally, lead was detected in 100 percent of samples collected at depths greater than 4 feet. Concentrations at this depth ranged from 8.3 mg/kg to 245 mg/kg, with the maximum detection observed in the 4- to 6-foot interval in core 005.

The highest mean detected concentration for lead (99.9 mg/kg) was observed in the 0- to 0.5-foot interval. The next highest mean detected concentration (87.6 mg/kg) was observed in the 4- to 6-foot interval.

Mudflat Samples (Lead)

Lead was detected in Mudflat samples at a frequency of 100 percent, with detected concentrations ranging from 12.8 mg/kg to 373 mg/kg. The maximum detected concentration for Mudflat samples was observed in Mudflat 1.

The highest mean detected concentration for lead (319 mg/kg) was observed in Mudflat 1, followed by Mudflat 2 (164 mg/kg).

4.1.3.5 Mercury

Overall, mercury was detected in 98 percent of all samples, 100 percent of all surface samples (i.e., 0 to 0.5 feet) and 96 percent of all subsurface samples (i.e., deeper than 0.5 feet). Detected concentrations ranged from 0.0000475 mg/kg to 21.5 mg/kg, with the maximum detected concentration observed in the 2- to 4-foot interval at location 005 (Figure 3-1).

The following paragraphs discuss additional details associated with mercury detections in both in-River and Mudflat samples.

In-River Samples (Mercury)

Mercury was detected in surface samples (0 to 0.5 feet) at a frequency of 100 percent. Detected concentrations ranged from 0.0000475 mg/kg to 11.8 mg/kg, with the maximum detection observed in core 005.

At the 0.5- to 2-foot and 2- to 4-foot intervals, mercury was detected collectively at a frequency of 95 percent, with detected concentrations ranging from 0.019 mg/kg to 21.5 mg/kg. The maximum mercury detection was observed in the 2- to 4-foot interval in core 005.

Mercury was detected in 100 percent of samples collected at depths greater than 4 feet. Detected concentrations at this depth ranged from 0.025 mg/kg to 11.1 mg/kg, with the maximum detection observed in the 4- to 6-foot interval in core 005.

The highest mean detected concentration for mercury (3.72 mg/kg) was observed in the 4- to 6-foot interval. The next highest mean detected concentration (2.25 mg/kg) was observed in the 8- to 10-foot interval.

Mudflat Samples (Mercury)

Mercury was detected in Mudflat samples at a frequency of 100 percent, with detections ranging from 0.056 mg/kg to 3.4 mg/kg. The maximum mercury detection was observed in Mudflat 4.

The highest mean detected concentration for mercury (2.53 mg/kg) was observed in Mudflat 2, followed by Mudflat 4 (2.44 mg/kg).

4.1.4 Aroclor PCBs

A total of 124 samples (105 in-River and 19 Mudflat) were analyzed for PCBs as part of the HRSA RI Program. Aroclor PCBs were measured in accordance with USEPA Method SW-846 3541/8082 using a GC/MS. Table D-4 of Appendix D presents individual sample results, while summary statistics for in-River and Mudflat samples (by depth) are presented in Appendix E.

The following provides a more detailed discussion of total Aroclor PCBs (sum of detected concentrations of Aroclors 1016, 1221, 1232, 1242, 1248, 1254 and 1260). In general, PCBs are considered to be of regional interest. These discussions are

supported by Appendices D and E, Figure 3-1 (which depicts the final coring locations) and Table 4-4 (which provides summary statistics).

As shown in Appendix E, individual Aroclor PCBs were detected in HRSA sediment at frequencies ranging from 7 to 17 percent, with Aroclor 1242 being detected most frequently. Aroclors 1016, 1221, 1232, 1262 and 1268 were not detected.

Overall, total Aroclor PCBs were detected in 27 percent of all samples, 46 percent of all surface samples (i.e., 0 to 0.5 feet) and 12 percent of all subsurface samples (i.e., deeper than 0.5 feet). Detected concentrations ranged from 30 µg/kg to 8,000 µg/kg, with the maximum detected concentration observed in the 0- to 0.5-foot interval at location 041 (Figure 3-1).

In-River Samples (Aroclor PCBs)

Total Aroclor PCBs were detected in surface samples (0 to 0.5 feet) at a frequency of 32 percent, with detected concentrations ranging from 31 µg/kg to 2,320 µg/kg and the maximum detection observed in core 028.

At the 0.5- to 2-foot and 2- to 4-foot intervals, total Aroclor PCBs were detected collectively at a frequency of 14 percent, with detected concentrations ranging from 30 µg/kg to 1,410 µg/kg. The maximum total Aroclor PCB detection was observed in the 0.5- to 2-foot interval in core 005. Total Aroclor PCBs were not detected at depths greater than 4 feet.

The highest mean detected concentration for total Aroclor PCBs (420 µg/kg) was observed in the 0- to 0.5-foot interval. The next highest mean detected concentration (353 µg/kg) was observed in the 0.5- to 2-foot interval.

Mudflat Samples (Aroclor PCBs)

Total Aroclor PCBs were detected in Mudflat samples at a frequency of 74 percent, with detected concentrations ranging from 114 µg/kg to 8,000 µg/kg. The maximum total Aroclor PCB detection for Mudflat samples was observed in Mudflat 2.

The highest mean detected concentration for total Aroclor PCBs (3,850 µg/kg) was observed in Mudflat 2, followed by Mudflat 1 (2,730 µg/kg).

4.1.5 Congener PCBs

A total of 124 samples (105 in-River and 19 Mudflat) were analyzed for congener PCBs as part of the HRSA RI Program. Congener PCBs were measured in accordance with USEPA method SW-846 INC/1668A using a high-resolution GC/MS. Table D-5 of Appendix D presents individual sample results, while summary statistics for in-River and Mudflat samples (by depth) are presented in Appendix E.

As presented in Appendix E, 208 of the 209 individual congener PCBs were detected in HRSA RI sediment at frequencies ranging from 1 percent to 94 percent, depending on the congener. Congener PCB-2 was detected most frequently.

Overall, total congener PCBs were detected in 100 percent of all samples. Detected concentrations ranged from 8.94 to 27,500,000 picograms per gram (pg/g), with the maximum concentration observed in the 0- to 0.5-foot interval of location 041 (Figure 3-1).

This section provides a more detailed discussion of total congener PCBs (sum of detected concentrations of the 209 individual congeners). As indicated previously, PCBs are of regional interest. These discussions are supported by Appendices D and E, Figure 3-1 (which depicts the final coring locations) and Table 4-5 (which provides summary statistics).

In-River Samples (Total Congener PCBs)

Total congener PCBs were detected in surface samples (i.e., 0 to 0.5 feet) at a frequency of 100 percent. Detected concentrations ranged from 8.94 pg/g to 2,270,000 pg/g, with the maximum detection observed in core 005.

At the 0.5- to 2-foot and 2- to 4-foot intervals, total congener PCBs were detected collectively at a frequency of 100 percent, with detected concentrations ranging from 8.94 pg/g to 2,610,000 pg/g. The maximum total congener PCB detection was observed in the 0.5- to 2-foot interval in core 005.

Finally, total congener PCBs were detected in 100 percent of samples collected at depths greater than 4 feet. Concentrations at this depth ranged from 12.9 pg/g to 257,000 pg/g, with the maximum detection observed in the 4- to 6-foot interval in core 005.

The highest mean detected concentration of total congener PCBs (237,000 pg/g) was observed in the 0- to 0.5-foot interval. The next highest mean detected concentration (106,000 pg/g) was observed in the 0.5- to 2-foot interval.

Mudflat Samples (Total Congener PCBs)

Total congener PCBs were detected in Mudflat samples at a frequency of 100 percent, with detections ranging from 794 pg/g to 27,500,000 pg/g. The maximum detection was observed in Mudflat 2.

The highest mean detected concentration of total congener PCBs (11,400,000 pg/g) was observed in Mudflat 2, followed by Mudflat 1 (6,010,000 pg/g).

4.1.6 Pesticides

A total of 124 samples (105 in-River and 19 Mudflat) were analyzed for pesticides as part of the HRSA RI Program. Pesticides were measured in accordance with USEPA Method SW-846 8081 using a GC instrument. Table D-6 of Appendix D presents individual sample results. Summary statistics for in-River and Mudflat samples by depth are presented in Appendix E.

As shown in Appendix E, pesticide constituents were detected in sediment samples at relatively low detection frequencies, with the exception of total DDT, which was detected in 71 percent of the samples. The five individual pesticides detected at the highest frequencies were 4,4-DDD (63 percent), Alpha-BHC (59 percent), dieldrin (51 percent) and 4,4-DDE and endrin aldehyde (47 percent each).

The following subsections provide a more detailed discussion of several pesticides identified as regional COIs, including 4,4-DDD, 4,4-DDE, 4,4-DDT and total DDT. These discussions are supported by Appendices D and E, Figure 3-1 (which depicts the final coring locations) and Table 4-6 (which provides summary statistics).

4.1.6.1 4,4-DDD

Overall, 4,4-DDD was detected in 63 percent of all samples, 82 percent of all surface samples (i.e., 0 to 0.5 feet) and 47 percent of all subsurface samples (i.e., deeper than 0.5 feet). Detected concentrations ranged from 0.55 µg/kg to 4,200 µg/kg, with the maximum detected concentration observed in the 0.5- to 2-foot interval at location 012 (Figure 3-1).

The following paragraphs discuss additional details associated with 4,4-DDD detections in both in-River and Mudflat samples.

In-River Samples (4,4-DDD)

4,4-DDD was detected in surface samples (i.e., 0 to 0.5 feet) at a frequency of 82 percent. Detected concentrations ranged from 0.55 µg/kg to 750 µg/kg, with the maximum detection observed in core 012.

At the 0.5- to 2-foot and 2- to 4-foot intervals, 4,4-DDD was detected collectively at a frequency of 46 percent, with detected concentrations ranging from 0.83 µg/kg to 4,200 µg/kg. The maximum 4,4-DDD detection was observed in the 0.5- to 2-foot interval in core 012.

Finally, 4,4-DDD was detected in 50 percent of samples collected at depths greater than 4 feet. Concentrations at these depths ranged from 0.82 µg/kg to 31 µg/kg, with the maximum detection observed in the 4- to 6-foot interval in core 005.

The highest mean detected concentration of 4,4-DDD (284 µg/kg) was observed in the 0.5- to 2-foot interval. The next highest mean detected concentration (62.6 µg/kg) was observed in the 0- to 0.5-foot interval.

Mudflat Samples (4,4-DDD)

4,4-DDD was detected in Mudflat samples at a frequency of 95 percent, with detections ranging from 0.92 µg/kg to 150 µg/kg. The maximum detection was observed in Mudflat 1.

The highest mean detected concentration of 4,4-DDD (81.7 µg/kg) was observed in Mudflat 1, followed by Mudflat 6 (34.3 µg/kg).

4.1.6.2 4,4-DDE

Overall, 4,4-DDE was detected in 47 percent of all samples, 73 percent of all surface samples (i.e., 0 to 0.5 feet) and 25 percent of all subsurface samples (i.e., deeper than 0.5 feet). Detected concentrations ranged from 0.36 µg/kg to 650 µg/kg, with the maximum detected concentration observed in the 0- to 0.5-foot interval at location 012 (Figure 3-1).

The following paragraphs discuss additional details associated with 4,4-DDE detections in both in-River and Mudflat samples.

In-River Samples (4,4-DDE)

4,4-DDE was detected in surface samples (i.e., 0 to 0.5 feet) at a frequency of 76 percent. Detected concentrations ranged from 0.36 µg/kg to 650 µg/kg, with the maximum detection observed in core 012.

At the 0.5- to 2-foot and 2- to 4-foot intervals, 4,4-DDE was detected collectively at a frequency of 25 percent, with detected concentrations ranging from 0.82 µg/kg to 470 µg/kg. The maximum 4,4-DDE detection was observed in the 0.5- to 2-foot interval in core 005.

Finally, 4,4-DDE was detected in 30 percent of samples collected at depths greater than 4 feet. Concentrations at these depths ranged from 1.2 µg/kg to 10 µg/kg, with the maximum detection observed in the 6- to 8-foot sampling interval in core 005.

The highest mean detected concentration of 4,4-DDE (65.9 µg/kg) was observed in the 0.5- to 2-foot interval. The next highest mean detected concentration (59.2 µg/kg) was observed in the 0- to 0.5-foot interval.

Mudflat Samples (4,4-DDE)

4,4-DDE was detected in Mudflat samples at a frequency of 95 percent, with detections ranging from 0.68 µg/kg to 68 µg/kg. The maximum detection was observed in Mudflat 1.

The highest mean detected concentration of 4,4-DDE (36.3 µg/kg) was observed in Mudflat 2, followed by Mudflat 6 (33.5 µg/kg).

4.1.6.3 4,4-DDT

Overall, 4,4-DDT was detected in 19 percent of all samples, 27 percent of all surface samples (i.e., 0 to 0.5 feet) and 12 percent of all subsurface samples (i.e., deeper than 0.5 feet). Detected concentrations ranged from 0.63 µg/kg to 1,400 µg/kg, with the maximum detected concentration observed in the 0.5- to 2-foot interval at location 012 (Figure 3-1).

The following paragraphs discuss additional details associated with 4,4-DDT detections in both in-River and Mudflat samples.

In-River Samples (4,4-DDT)

4,4-DDT was detected in surface samples (i.e., 0 to 0.5 feet) at a frequency of 16 percent. Detected concentrations ranged from 0.63 µg/kg to 100 µg/kg, with the maximum detection observed along Transect 5 in core 005.

At the 0.5- to 2-foot and 2- to 4-foot intervals, 4,4-DDT was detected collectively at a frequency of 14 percent, with detected concentrations ranging from 3.5 µg/kg to 1,400 µg/kg. The maximum 4,4-DDT detection was observed in the 0.5- to 2-foot interval in core 012. 4,4-DDT was not detected in samples collected at depths greater than 4 feet.

The highest mean detected concentration of 4,4-DDT (249 µg/kg) was observed in the 0.5- to 2-foot interval. The next highest mean detected concentration (27.6 µg/kg) was observed in the 0- to 0.5-foot interval.

Mudflat Samples (4,4-DDT)

4,4-DDT was detected in Mudflat samples at a frequency of 47 percent, with detections ranging from 1.8 µg/kg to 48 µg/kg. The maximum detection was observed in Mudflat 6.

The highest mean detected concentration of 4,4-DDT (32.5 µg/kg) was observed in Mudflat 6, followed by Mudflat 4 (15.7 µg/kg).

4.1.6.4 Total DDT

Overall, total DDT was detected in 71 percent of all samples, 91 percent of all surface samples (i.e., 0 to 0.5 feet) and 54 percent of all subsurface samples (i.e., deeper than 0.5 feet). Detected concentrations ranged from 0.57 µg/kg to 5,600 µg/kg, with the maximum detected concentration observed in the 0.5- to 2-foot interval at location 012 (Figure 3-1).

The following paragraphs discuss additional details associated with total DDT detections in both in-River and Mudflat samples.

In-River Samples (Total DDT)

Total DDT was detected in surface samples (0 to 0.5 feet) at a frequency of 86 percent. Detected concentrations ranged from 0.57 µg/kg to 1,400 µg/kg, with the maximum detection observed in core 012.

At the 0.5- to 2-foot and 2- to 4-foot intervals, total DDT was detected collectively at a frequency of 86 percent, with detected concentrations ranging from 0.82 µg/kg to 5,600 µg/kg. The maximum total DDT detection was observed in the 0.5- to 2-foot interval in core 012.

Total DDT was detected in 50 percent of samples collected at depths greater than 4 feet. Concentrations at this depth ranged from 0.82 µg/kg to 31 µg/kg, with the maximum detection observed in the 4- to 6-foot interval in core 005.

The highest mean detected concentration of total DDT (329 µg/kg) was observed in the 0.5- to 2-foot interval. The next highest mean detected concentration (103 µg/kg) was observed in the 0- to 0.5-foot interval.

Mudflat Samples (Total DDT)

Total DDT was detected in Mudflat samples at a frequency of 100 percent, with detected concentrations ranging from 1.6 µg/kg to 218 µg/kg. The maximum detection was observed in Mudflat 1.

The highest mean detected concentration of total DDT (115 µg/kg) was observed in Mudflat 1, followed by Mudflat 6 (89.5 µg/kg).

4.1.7 Herbicides

A total of 124 samples (105 in-River and 19 Mudflat) were analyzed for herbicides as part of the HRSA RI Program. Herbicides were measured in accordance with USEPA Method 8151A using a GC with an electron capture detector. Table D-7 of Appendix D presents individual sample results, while summary statistics for in-River and Mudflat samples (by depth) are presented in Appendix E.

As shown in Appendix E, herbicides were not detected in any HRSA sediment samples.

4.1.8 Dioxins/Furans

A total of 124 samples (105 in-River and 19 Mudflat) were analyzed for dioxins/furans as part of the HRSA RI Program. Dioxins/furans were measured in accordance with USEPA Method SW-846 1613 using a high-resolution GC/MS. Table D-8 of Appendix D presents individual sample results, while summary statistics for in-River and Mudflat samples (by depth) are presented in Appendix E.

As shown in Appendix E, congener-specific dioxins/furans were detected in HRSA samples at frequencies ranging from 58 percent to 100 percent. The five congener-specific dioxins/furans detected at the highest frequencies were octachlorodibenzo-p-dioxin (OCDD) (100 percent); 1,2,3,4,6,7,8-HpCDD (98 percent); 1,2,3,6,7,8-HxCDD (94 percent); 1,2,3,7,8,9-HxCDD (91 percent); and 1,2,3,4,7,8-HxCDD (86 percent).

The following text discusses 2,3,7,8-TCDD in more detail. This congener was selected as a representative compound to discuss the distribution of the dioxin/furan group of compounds, as it typically makes up the majority of the TEQ for 2,3,7,8-substituted dioxins/furans in this system. These discussions are supported by Appendices D and E, Figure 3-1 (which depict the final coring locations) and Table 4-7 (which provides summary statistics).

4.1.8.1 2,3,7,8-TCDD

Overall, 2,3,7,8-TCDD was detected in 73 percent of all samples, 98 percent of all surface samples (i.e., 0 to 0.5 feet) and 53 percent of all subsurface samples (i.e., deeper than 0.5 feet). Detected concentrations ranged from 0.113 pg/g to 2,990 pg/g, with the maximum detected concentration observed in the 0- to 0.5-foot interval at location 005 (Figure 3-1).

The following paragraphs discuss additional details associated with 2,3,7,8-TCDD detections in both in-River and Mudflat samples.

In-River Samples (2,3,7,8-TCDD)

2,3,7,8-TCDD was detected in surface samples (0 to 0.5 feet) at a frequency of 97 percent. Detected concentrations ranged from 0.181 pg/g to 2,990 pg/g, with the maximum detection observed in core 005.

At the 0.5- to 2-foot and 2- to 4-foot intervals, 2,3,7,8-TCDD was detected collectively at a frequency of 57 percent, with detected concentrations ranging from 0.113 pg/g to 1,370 pg/g. The maximum 2,3,7,8-TCDD detection was observed in the 0.5- to 2-foot sampling interval in core 005.

2,3,7,8-TCDD was detected in 33 percent of samples collected at depths greater than 4 feet, with detected concentrations ranging from 0.327 pg/g to 3.19 pg/g. The only detected concentrations of 2,3,7,8-TCDD were observed in core 005, with the maximum detected concentration observed in the 4- to 6-foot interval.

The highest mean detected concentration of 2,3,7,8-TCDD (121 pg/g) was observed in the 0- to 0.5-foot interval. The next highest mean detected concentration (66.7 pg/g) was observed in the 0.5- to 2-foot sampling interval.

Mudflat Samples (2,3,7,8-TCDD)

2,3,7,8-TCDD was detected in Mudflat samples at a frequency of 100 percent, with detected concentrations ranging from 0.241 pg/g to 310 pg/g. The maximum 2,3,7,8-TCDD detection was observed in Mudflat 4.

The highest mean detected concentration of 2,3,7,8-TCDD (148 pg/g) was observed in Mudflat 4, followed by Mudflat 2 (134 pg/g).

4.1.9 Miscellaneous

A total of 124 samples (105 in-River and 19 Mudflat) were analyzed for TEPH, TOC, pH, and ORP as part of the HRSA RI Program. TEPH was measured in accordance with NJ-TPH-QAM-028-10/91 Method using a GC/FID instrument. TOC was measured in accordance with the Lloyd Kahn Method, using a carbonaceous analyzer. Table I of Appendix D presents individual sample results, while summary statistics for in-River and Mudflat samples by depth are presented in Appendix E.

This section summarizes TEPH and TOC detections, and pH/ORP measurements. These discussions are supported by Appendices D and E, Figure 3-1 and Table 4-8.

4.1.9.1 TEPH

Overall, TEPH was detected in 98 percent of all samples, 100 percent of surface samples (0- to 0.5-foot interval) and 97 percent of subsurface samples (below 0.5 feet).

Detected concentrations ranged from 6.9 mg/kg to 190,000 mg/kg, with the maximum detected concentration observed in the 0.5- to 2-foot interval at location 012 (Figure 3-1).

The following paragraphs discuss additional details associated with TEPH detections in both in-River and Mudflat samples.

In-River Samples (TEPH)

TEPH was detected in surface samples (0 to 0.5 feet) at a frequency of 100 percent. Detected concentrations ranged from 7.8 mg/kg to 180,000 mg/kg, with the maximum detection observed in core 012, located on the eastern side of the River.

At the 0.5- to 2-foot and 2- to 4-foot intervals, TEPH was detected collectively at a frequency of 96 percent, with detected concentrations ranging from 6.9 mg/kg to 190,000 mg/kg. The maximum TEPH detection was observed in the 0.5- to 2-foot sampling interval in core 012.

TEPH was detected in 100 percent of samples collected at depths greater than 4 feet, with detected concentrations ranging from 12 mg/kg to 2,200 mg/kg. The maximum TEPH detection was observed in the 8- to 10-foot interval in core 005.

The highest mean detected concentration (24,300 mg/kg) was observed in the 10- to 12-foot interval. The next highest mean detected concentration (6,320 mg/kg) was observed in the 0.5- to 2-foot interval.

Mudflat Samples (TEPH)

TEPH was detected in Mudflat samples at a frequency of 100 percent, with detected concentrations ranging from 30 mg/kg to 3,400 mg/kg. The maximum TEPH detection was observed in Mudflat 1.

The highest mean detected concentration (1,560 mg/kg) was observed in Mudflat 2, followed by Mudflat 1 (1,340 mg/kg).

4.1.9.2 TOC

TOC was detected in 95 percent of all samples, 93 percent of surface samples (0- to 0.5-foot interval) and 97 percent of subsurface samples (below 0.5 feet). Detected

levels ranged from 1,085 mg/kg to 540,000 mg/kg, with the maximum detected level observed in the 0.5- to 2-foot interval at location 012.

The following paragraphs discuss additional details associated with TOC detections in both in-River and Mudflat samples.

In-River Samples (TOC)

TOC was detected in surface samples (0 to 0.5 feet) at a frequency of 89 percent. Detected levels ranged from 1,085 mg/kg to 220,000 mg/kg, with the maximum detection observed in core 012.

At the 0.5- to 2-foot and 2- to 4-foot intervals, TOC was detected collectively at a frequency of 96 percent, with detected levels ranging from 1,300 mg/kg to 540,000 mg/kg. The maximum TOC detection was observed in the 0.5- to 2-foot interval in core 012.

TOC was detected in 100 percent of samples collected at depths greater than 4 feet, with detected levels ranging from 39 mg/kg to 39,000 mg/kg. The maximum TOC detection was observed in the 8- to 10-foot interval in core 005.

The highest mean detected level (35,400 mg/kg) was observed in the 0.5- to 2-foot interval. The next highest mean level (29,700 mg/kg) was observed in the 8- to 10-foot interval.

Mudflat Samples (TOC)

TOC was detected in Mudflat samples at a frequency of 100 percent, with detected levels ranging from 8,800 mg/kg to 170,000 mg/kg. The maximum TOC detection was observed in Mudflat 9.

The highest mean detected level (106,000 mg/kg) was observed in Mudflat 9, followed by Mudflat 2 (40,000 mg/kg).

4.1.9.3 pH/ORP

pH and ORP was measured in all samples from the HRSA RI Program. Overall, ORP levels ranged from 63.6 mV to 447 mV and pH ranged from 4.63 to 8.88 (pH units). These results are summarized in Table 4-8.

pH and ORP information was collected to aid in the assessment of the samples capability of sustaining chromium in the +6 valence state. The pH and ORP values for each sample were plotted on an ORP-pH Phase Diagram to determine the oxidation-reduction (redox) status of the sample matrices. The pH and ORP of the samples provides important information to assess the tendency of hexavalent chromium to exist in the investigative samples and to assist in the interpretation of QC data for pre-digestion matrix spike recoveries.

The following paragraphs discuss additional details associated with ORP detections in both in-River and Mudflat samples. These results are summarized in Table 4-8.

In-River Samples (pH/ORP)

All In-River samples, except HRRISED007E-01(0- to 0.5-feet) and HRRISED009C-01(0- to 0.5-feet) exhibited reducing characteristics as plotted on the pH/ORP Phase diagram. The ph/ORP plots for samples HRRISED007E-01(0- to 0.5-feet) and HRRISED009C-01(0- to 0.5-feet) were in the oxidizing region of the pH/ORP Phase diagram, slightly above the oxidizing/reducing transition zone.

Mudflat Samples (pH/ORP)

pH and ORP was measured and plotted for all Mudflat samples. The Mudflat samples exhibited reducing characteristics as the pH/ORP plots for all the Mudflat samples were in the reducing zone of the pH/ORP Phase diagram.

4.1.10 AVS/SEM

A total of 56 surface samples were analyzed for AVS/SEM as part of the HRSA RI Program. Table D-10 of Appendix D presents results for individual samples. Summary statistics for in-River and Mudflat samples by depth are presented in Appendix E. AVS/SEM analyses were performed in accordance with EPA-821-R-91-100/6010B Method using inductively coupled plasma/cold vapor atomic absorption (ICP/CVAA).

AVS/SEM is a technique for assessing metal bioavailability. AVS binds some metals to form insoluble sulfide complexes that limit their bioavailability. SEM_T is the molar sum of the concentrations of metals extracted simultaneously with AVS. SEM metals for this study included cadmium, copper, lead, mercury, nickel, silver and zinc. Results of the ratio of SEM_T to AVS are provided in Table 4-9.

4.2 Radiochemistry

For radiochemistry analyses, Be-7, Pb-210 and Cs-137 activity was measured at six core locations during the sampling program. The purpose of these analyses was to assist in dating the sediment and also to help verify sediment deposition rates. The following sections briefly explain each analysis. Individual sample results are presented in Table D-12 of Appendix D.

4.2.1 Beryllium-7

Six in-River surface samples were analyzed for Be-7 as part of the HRSA RI Program. Be-7 analyses were performed using gamma spectroscopy. Be-7 was detected in only one sample at a concentration of 0.69 picocurries per gram (pCi/g) at location 005.

4.2.2 Cesium-137

A total of 57 in-River samples were analyzed for Cs-137 as part of the HRSA RI Program. Cs-137 analyses were performed using gamma spectroscopy. Cs-137 was not detected in any samples.

4.2.3 Lead-210

A total of 57 in-River samples were analyzed for Pb-210 as part of the HRSA RI Program, using beta detection methods. Pb-210 was detected in 100 percent of samples, with detected concentrations ranging from 0.364 to 1.37 pCi/g.

4.3 Physical Parameters

Various physical parameters were observed/measured during the HRSA RI Program. This section describes the information/data collected as part of this program component.

4.3.1 Visual Lithologic Descriptions

To provide first-order observations of sediment characteristics (e.g., color, type, odor, visual impacts), visual descriptions of all sediment cores were provided by a geologist using the Unified Soil Classification System. These descriptions were transcribed in the core lithology forms, presented in Appendix C.

Of particular note were those sediment samples containing oil-like substances and sheens, and petroleum-like odors. A summary of the locations and depths of these sediments is shown in the table below.

Core Location	*Depth Interval*
006	0.5 to 1.8 feet
011	0 to 0.2 feet
011	1.8 to 2.9 feet
012	0 to 1.85 feet
013	0 to 0.5 feet

4.3.2 Grain Size

To adequately characterize the in-situ and Mudflat sediments, grain-size analyses were conducted for a series of samples at various locations and depths.

A total of 122 samples were analyzed for grain size as part of the HRSA RI Program, representing approximately 98 percent of the total samples obtained during this investigation. Grain-size analyses were performed in accordance with the ASTM D422 Method using a hydrometer and sieves. Table D-11 of Appendix D presents results for individual samples. Summary statistics for in-River and Mudflat samples by depth are presented in Appendix E.

Data were provided from the laboratory for each sample as “percent passing by weight” for the various sieve diameters (in millimeters [mm]). As such, the data were segmented by grain-size class as shown in the table below.

Classification	*Diameter (mm)*
Gravel	4.75
Sand	0.075
Silt	0.002
Clay	<0.002

To better understand the critical distribution of coarse-grained versus fine-grained materials within the matrix of materials tested, the data were transformed into “percent retained by weight” by solving for the differences between the above size classifications, as shown in the table below.

Classification	*Calculation*
Gravel	100 – (Percent passing at 3.35 mm)
Sand	(Percent passing at 3.35 mm) – (Percent passing at 0.064 mm)
Silt	(Percent passing at 0.064 mm) – (Percent passing at 0.001 mm)
Clay	Percent passing at 0.001 mm

For each HRSA sample analyzed, Table 4-10 summarizes grain size as percent by weight for the classifications listed above.

In-River Samples

Tables E-4 through E-11 of Appendix E present summary statistics for all grain-size fractions for in-River samples by depth. Mean values and ranges for the individual fractions discussed above are presented in Table 4-11 as percent passing by weight.

Results indicate that the in-River sediments are somewhat interchangeable between sand and silt, with the sandier matrix found closer to the surface and the finer-grained materials at depth. The sediments become more distinctly fine grained at depths between 4 and 8 feet below the mudline.

Mudflat Samples

Tables E-12 through E-18 of Appendix E present summary statistics for all grain-size fractions for Mudflat samples. Mean values and ranges for the individual fractions discussed above are presented in Table 4-11 as percent passing by weight.

Results of the Mudflat sampling indicate that, in comparison to the in-River samples, sediments are more fine grained.

4.4 Sediment Chemical Data Quality

4.4.1 Data Quality Parameters Overview

The following subsections provide an overview of the data quality parameters applied to the HRSA RI Program, including precision, accuracy, representativeness/comparability and completeness.

4.4.1.1 Precision

Precision, defined as the numerical agreement between two or more measurements, was evaluated by comparing the results of laboratory duplicate analyses, such as MS/MSD pairs and field duplicate samples. A small portion of the data was qualified due to imprecision. Laboratory duplicate results are discussed in detail in the data validation reports presented in Appendix F. A discussion of the field duplicate sample results is presented in Section 4.4.2.2.

4.4.1.2 Accuracy

Accuracy, defined as the proximity of a measurement to the accepted or true value, was evaluated by comparing the results of QC analyses to known concentrations using project-specific or laboratory-derived acceptance limits. A portion of the data was qualified due to results that did not meet the accuracy acceptance criteria. Some of the qualifications were a result of matrix interference, which is common in complex environmental samples. The specific qualifications imposed due to accuracy issues are addressed in the data validation reports presented in Appendix F.

4.4.1.3 Representativeness and Comparability

Representativeness and comparability of results were achieved by using standardized field sample collection and sample handling procedures, and through laboratory compliance with the analytical methods prescribed in the approved HRSA RIWP (BBL, 2005a).

4.4.1.4 Completeness

Overall analytical completeness was defined in Section 5.2.2.3 of the approved HRSA RIWP (BBL, 2005a) as the ratio of the total valid analytical data results (including estimated values) to the total number of analytical results requested on the samples submitted for analysis. Valid analytical results are defined as those results that were not rejected (qualified with an “R”) during data validation.

To calculate the analytical completeness for the HRSA RI data, the project database was queried to determine the number of results for each analysis that were valid as reported, and the number of results that were qualified with each code identified in Section 3.3.1.2. The overall analytical completeness was then calculated as follows:

$$\% \text{ Analytical Completeness} = \frac{\text{Total Valid Analytical Data}}{\text{Analytical Data Obtained}} \times 100$$

The analytical completeness was calculated for each analysis and ranged from 97 percent to 100 percent. The average analytical completeness across all analyses was 99.9 percent. The analytical completeness goal stated in the approved HRSA RIWP (BBL, 2005a) was 85 percent.

In addition to the quantitative percent analytical completeness, a Qualitative Data Quality (QDQ) value was also assigned to each analysis. The QDQ index was based on professional judgment and experience, and was developed to provide a qualitative framework to discuss the data quality. The QDQ for the project data set ranged from Very Good to Excellent. The QDQ index is provided in the table below.

Qualitative Data Quality	***Percent Analytical Completeness (≥)***
Excellent	100%
Very Good	95%
Good	90%
Above Average	85%
Average	80%
Poor	<80%

Table 4-13 shows the QDC for each analysis fraction according to the percent analytical completeness.

4.4.2 Data Usability

4.4.2.1 Data Validation Observations

As stated above, the average analytical completeness across all fractions was 99.9 percent. The following is an overview of issues observed during data validation, some of which resulted in the qualification of sample results:

- Low sample sizes (less than the method-specified minimum of 4.5 grams) were observed for many VOC sediment samples collected in EnCore™ samplers. This is not uncommon for sediment samples with high moisture

content. The reporting limits for VOCs were adjusted to reflect the actual volume of sample used.

- Matrix interference in the pesticide analyses resulted in chromatography issues, low surrogate recoveries and imprecision between the results of the dual-column analyses. In addition, several samples required dilutions, thus raising the reporting limits for pesticide compounds.

- Several congener PCB extracts could not be concentrated to the method-specified 100 microliters (μL) due to unidentified interferents that caused the extracts to crystallize before reaching final volume. A 500 μL final extract volume was used in these cases and the reporting limits for congener PCBs in the affected samples were raised five-fold.

- Specified lower control limits for SVOC recovery in the LCS analyses, and for herbicide recovery in the MS/MSD analyses, specified in the approved HRSA RIWP (BBL, 2005a) were significantly higher than the laboratory's statistically derived acceptance limits. As a result, numerous qualifiers were applied for low recoveries in these fractions.

- In several cases where reanalysis of samples was required due to out-of-criteria QC results, the laboratory performed the reanalyses beyond the required holding time and data were qualified as estimated as a result.

- Several SVOC samples were observed to contain high concentrations of PAH compounds. In some cases, samples were analyzed at initial dilutions to achieve results within the calibration range and to protect the laboratory instrumentation from overload. As a result, the reporting limits for "not-detected" SVOCs were elevated in these cases.

- Due to a routing error, UPS delivered one set of samples to the laboratory one day later than expected. Consequently, the preparation holding time of 48 hours for 11 VOC samples collected in EnCore™ samplers was slightly exceeded (by less than four hours). In general, VOCs were not detected in the affected samples and the PRG decided not to recollect. The results for VOCs in the 11 affected samples were qualified as estimated due to the marginal holding time exceedance.

- Approximately 25 samples were observed to contain greater than 50 percent moisture (flagged "M"). All sample results are reported on a dry-weight basis and thus incorporate any variance due to moisture content.

The data validation reports included in Appendix F present specific details on findings and address their impact on data usability.

4.4.2.2 Field Duplicate Results

Sediment field duplicate samples were submitted with each sample delivery group (SDG) and analyzed for all target parameters. The identity of the field duplicate samples was not known by the laboratory. The precision criteria that were used to evaluate the field duplicate results are as follows:

- For field duplicate pairs where both results were greater than or equal to five times the reporting limit, the relative percent difference (RPD) between the results had to be less than 40 percent.

- For field duplicate pairs where at least one result was less than five times the reporting limit (including when one result was a nondetect), the difference between the results had to be less than two times the reporting limit.

A value of half the reporting limit was used for nondetected results in the difference calculation. A quantitative evaluation of precision is not applicable for analytes that were nondetect in either sample of a field duplicate pair. Field duplicate results that did not meet the acceptance criteria were qualified as estimated ("J" for positive results and "UJ" for nondetects).

A summary of the field duplicate results is presented in Table 4-14 and includes the information presented below:

- The total number of field duplicate pairs is presented in the column with the heading "Total Number of Field Duplicate Pairs." This column presents the total number of field duplicate pairs for each analyte as well as the total number of field duplicate result pairs.

- The total number of the field duplicate pairs that had nondetect results in both the parent sample and field duplicate is presented in the column with the heading "Total Number of Field Duplicate Pairs with Nondetects for Both

Samples." In these cases, the field duplicate precision criteria are met because both results are nondetect. This information is also presented by analyte.

- The total number of the field duplicate pairs that had positive results in the field duplicate and/or parent sample is presented in the columns under the heading "Total Number of Field Duplicate Pairs with Positives in Either Sample." The total number of samples, number of samples that met the criteria, number of samples that did not meet the criteria, percentage of samples that met the criteria and number of samples that did not meet criteria are presented. This information is also presented by analyte.

- The overall percentage of results that met the applicable criteria is presented in the column with the heading "Overall Percent of Samples that Met Criteria." This information is also presented by analyte.

A total of eight field duplicate pairs were submitted for organic, inorganic and general chemistry analyses. Additionally, three field duplicate pairs were analyzed for Pb-210 and Cs-137, and one field duplicate pair was analyzed for Be-7. Overall, a high percentage (89 percent) of the total field duplicate results met the acceptance criteria. The greatest variance among field duplicate results for individual analytes was observed for dioxin/furans and Congener PCBs (25 percent to 100 percent met criteria), and for metals (63 percent to 100 percent met criteria). In addition, 75 percent of the field duplicate results for TEPH, AVS, ORP and TOC met criteria.

4.4.2.3 Field Blank Results

Equipment blanks were collected to monitor external contamination during sample collection at the frequency described in Section 6.5.1.1 of the approved HRSA RIWP (BBL, 2005a). Summary statistics for the equipment blanks with positive results greater than the MDL for target analytes are presented on Table 4-15. Of the nine equipment blanks collected, one blank had a positive result for methylene chloride, five blanks had detectable concentrations of one or more dioxin/furan, and all but one blank had trace-level results for one or more congener PCB. Additionally, all blanks reported positive results for metals and one blank had a detectable concentration of cyanide. Target compounds were not observed in the equipment blanks for the remaining fractions.

Methylene chloride, OCDD and octachlorodibenzofuran (OCDF) are common laboratory contaminants and their presence in the equipment blanks may not be

indicative of introduction during sample collection. Likewise, due to the sensitivity of the method and their affinity for laboratory glassware, sporadic low-level detections of congener PCBs in blanks are not uncommon. Aluminum, beryllium, manganese, potassium and zinc were the most common contaminants in the metals fraction. The impact on data usability due to equipment blank contamination was assessed during the data validation process and affected sample results were qualified “U”.

5. Remedial Investigation Data Analysis

This section provides additional detail on the sediment data presented in Section 4. Specifically, it evaluates horizontal and vertical trends for the regional COIs identified, including BTEX, 1-2-DCB, 1,3-DCB, 1,4-DCB, 1,2,4-TCB, naphthalene, total PAHs, total chromium, hexavalent chromium, total cyanide, lead, mercury, total congener PCBs, total DDT, and 2,3,7,8-TCDD.

From a horizontal perspective, COI concentration trends were evaluated longitudinally (i.e., progressing upriver) along the HRSA, as well as laterally (i.e., spanning across the River), as appropriate. To aid in this latter assessment, sampling locations were divided into two groups: eastern side of the River (20 in-River and 13 Mudflat locations) and western side of the River (17 in-River and six Mudflat locations).

From a vertical perspective, COI concentration trends were evaluated according to sampling depth interval. Of the 56 sampling locations (37 in-River and 19 Mudflat), 56 samples were collected from the 0- to 0.5-foot interval, 36 samples were collected from the 0.5- to 2-foot interval, 20 samples were collected from the 2- to 4-foot interval and three samples each were collected from the 4- to 6-foot, 6- to 8-foot, 8- to 10-foot and 10- to 12-foot intervals.

Table 5-1 lists the final sampling locations, including the longitudinal orientation (sampling transect/Mudflat), lateral orientation (east versus west) and depth intervals sampled for each. Table 3-1 (provides coordinates of final coring locations) and Figure 3-1 (depicts the final coring locations) also serve as useful reference points for this discussion.

In addition to the horizontal and vertical trends evaluation discussed in this section, a brief comparison was made between the HRSA RI data and data previously collected by the PRG. For each identified COI, Table 5-2 provides a sediment comparison of the arithmetic mean of detected concentrations. The PRG sediment dataset consisted of the following programs:

- the 1991-1993 Diamond Site Remedial Investigation Program
- the 2004 Diamond Site Toxicity Study
- the 1996-1997 SCCC Site Focused Remedial Investigation, the 2000 SCCC Site Remedial Investigation Program

- the 2002 SCCC SSL Superfund Contract Support Team Sampling Program

A more detailed discussion of these sampling programs is provided in Section 2.2 of this RI Report.

5.1 Observed Trends in Sediments — Analytical Chemistry

For each analytical class, general observations regarding the overall presence and extent of contamination are presented. Scatter plots (Figures 5-1 through 5-18) are then used to describe observed trends of specific COIs throughout the HRSA. Each figure includes up to seven plots that present the following information:

1. in-River sample results from all depth intervals
2. in-River sample results from all depth intervals *at a reduced scale*
3. in-River sample results from the 0- to 0.5-foot depth interval
4. in-River sample results from the 0- to 0.5-foot depth interval *at a reduced scale*
5. in-River sample results from the 0.5- to 2-foot and 2- to 4-foot depth intervals
6. in-River sample results from the 0.5- to 2-foot and 2- to 4-foot depth intervals *at a reduced scale*
7. Mudflat sample results from the 0- to 0.5-foot depth interval

The scatter plots were developed using one-half the SQL for non-detect values. Additionally, where appropriate, the parent and duplicate samples were averaged together to create one result. As noted, several graphs are presented at a reduced scale to provide a better view of any apparent trends at the lower end of the concentration range. These reduced-scale graphs may not show the relatively higher concentrations that are illustrated on the graphs with expanded scales.

Given the similarities in detected concentrations, samples collected from the 0.5- to 2-foot and 2- to 4-foot depth intervals were presented on the same graphs. Additionally, concentrations from samples collected at depths greater than 4 feet were not

segregated because only three samples were collected from each of the associated depth intervals (i.e., 4- to 6-feet, 6- to 8-feet, 8- to 10-feet and 10- to 12-feet).

Sections 5.1.1 through 5.1.6 discuss observed trends for each analytical constituent class and associated COI(s).

5.1.1 VOCs

The following subsections discuss the four identified regional COIs in greater detail (i.e., benzene, toluene, ethylbenzene and xylene), and focus on general observations as they relate to horizontal and/or vertical concentration trends.

5.1.1.1 Benzene

Benzene was detected in only 10 percent of HRSA RI samples, with concentrations ranging from 3.3 µg/kg to 1,800 µg/kg. All detected concentrations were found in the in-River samples and levels were generally below 10 µg/kg (Figure 5-1). However, concentrations up to 1,800 µg/kg were observed at Transect 7 along the eastern side of the River (core 008). To a lesser extent, samples collected along Transect 11 were also shown to contain relatively higher concentrations. In this case, samples obtained from both cored locations (011 and 012) varied in concentration up to 280 µg/kg. Overall, the highest detected levels of benzene were found within the southern portion of the HRSA, primarily along the eastern side of the River.

As depicted in Table 4-1, the highest mean detected concentration of benzene was found in the 0- to 0.5-foot interval. From the surficial interval, mean concentrations generally tend to decrease through the sediment column. In particular, the mean benzene concentration drops 82.2 percent between the 0.5- to 2-foot and the 2- to 4-foot intervals. Below 4 feet, mean benzene concentrations are at least one order of magnitude lower than those found above this point. Consistent with these findings, the two highest individual benzene concentrations were noted in the top 2 feet of sediment: 1,800 µg/kg at core location 008 (0.5 to 2 feet) and 1,300 µg/kg at location 008 (0 to 0.5 feet).

Benzene was not detected in Mudflat samples; therefore, those results are not presented on Figure 5-1, nor are they discussed further herein.

5.1.1.2 Toluene

Of the four VOC COIs discussed, toluene was detected most frequently (17 percent), with concentrations ranging from 0.89 µg/kg to 1,400 µg/kg. Of the detected concentrations, all but one were found in the in-River samples and levels were generally below 10 µg/kg (Figure 5-2). There were, however, exceptions to this, including several samples collected at Transect 11 that contained relatively higher concentrations on both sides of the River (cores 011 and 012). Specifically, core 011 (western side) produced a level of 470 µg/kg, while core 012 (eastern side) was shown to contain toluene at 1,400 µg/kg. As depicted in Table 4-1, the highest mean detected concentration of toluene was found in the 2- to 4-foot interval. Despite this, the highest concentration (1,400 µg/kg) was noted in the 0.5- to 2-foot interval at core location 012. Similar to benzene, mean concentrations decreased significantly beyond 4 feet (i.e., deeper in the sediment column).

Toluene was detected in only one Mudflat sample (Mudflat 1) at a concentration of 2.2 µg/kg. Due to the limited number of detected values, trends could not be determined and concentrations are not shown on Figure 5-2.

5.1.1.3 Ethylbenzene

Ethylbenzene was detected in only 10 percent of HRSA RI samples, with concentrations ranging from 3.8 µg/kg to 8,600 µg/kg. All detected concentrations were found in the in-River samples, and levels were generally below 10 µg/kg (Figure 5-3). Once again, exceptions included samples collected along Transects 7 and 11. Specifically, Transect 7 showed relatively higher concentrations (5,300 µg/kg) along the eastern side of the River (core 008). Additionally, samples collected at Transect 11 showed relatively higher concentrations of ethylbenzene on both sides of the River (cores 011 and 012), with levels varying up to 8,600 µg/kg. Overall, the highest concentrations were generally found in the southern end of the HRSA. Once again, however, an elevated detection was also noted on the western side of Transect 22 (core 001).

As depicted in Table 4-1, the highest mean detected concentration of ethylbenzene was found in the 2- to 4-foot interval. Similar to toluene, mean concentrations below 4 feet were found to be significantly lower. The three highest individual concentrations were detected at three discrete intervals, shown in descending order: 8,600 µg/kg (2 to 4 feet; core 011), 5,800 µg/kg (0.5 to 2 feet; core 012), and 5,300 µg/kg (0 to 0.5 feet; core 008).

Ethylbenzene was not detected in Mudflat samples; therefore, the results are not presented on Figure 5-3, nor are they discussed further herein.

5.1.1.4 Xylene

Similar to the other VOC COIs, xylene was detected in a small percentage of HRSA RI samples (11 percent), with concentrations ranging from 13 µg/kg to 12,000 µg/kg. All detected concentrations were found in the in-River samples, and levels were generally below 30 µg/kg (Figure 5-4). Transect 11 again proved to be the exception, with relatively elevated concentrations (up to 12,000 µg/kg) found along both sides of the River (cores 011 and 012). To a much lesser degree, Transect 22 (core 001) also contained relatively higher concentrations (up to 69 µg/kg). Overall, and similar to the other VOC COIs, the southern end was shown to contain the highest levels of xylene. In addition, four of the six detected concentrations found above 30 µg/kg were located along the western side of the River.

As depicted in Table 4-1, the highest mean detected concentration of xylene was in the 2- to 4-foot interval, with mean concentrations decreasing significantly beyond this point (i.e., deeper in the sediment column). In comparison to the 2- to 4-foot interval, the surficial mean concentration was one order of magnitude lower. The two highest individual concentrations of 12,000 and 10,000 µg/kg were detected at the 0.5- to 2-foot (core 012) and 2- to 4-foot (core 011) intervals, respectively.

Xylene was not detected in Mudflat samples; therefore, the results are not presented on Figure 5-4, nor are they discussed further herein.

5.1.1.5 VOC Summary

Overall, VOC detection frequencies were low in HRSA samples and the majority of constituents analyzed were not detected. Similarly, COI concentrations found in the in-River samples were generally low throughout the HRSA, although relatively higher concentrations were consistently noted along two transects (7 and 11) located in the southern portion of the HRSA. Several elevated detections were also noted along Transect 22, located further north. With the exception of benzene, the highest mean concentration was generally found in the 2- to 4-foot interval. The highest mean concentration of benzene detections was found at the sediment surface. VOCs were not typically found in Mudflat samples.

As shown in Table 5-2, a comparison of these results to data previously collected by the PRG within the HRSA showed that mean detected concentrations of benzene and ethylbenzene were approximately four times higher in samples previously collected by the PRG. The comparison of toluene and xylene results showed that mean detected concentrations were generally consistent between the previously collected and RI samples.

5.1.2 SVOCs

The following subsections discuss the six identified regional COIs in greater detail (i.e., 1,2-DCB, 1,3-DCB, 1,4-DCB, 1,2,4-TCB, naphthalene and total PAHs), focusing on general observations as they relate to horizontal and/or vertical concentration trends.

Due to high detections of some individual PAHs, dilutions were performed on many SVOC samples. As a result, SQLs for nondetect results were significantly higher than those prescribed in the approved HRSA RIWP (BBL, 2005a).

5.1.2.1 1,2-Dichlorobenzene

1,2-DCB was detected in a small percentage of HRSA RI samples (12 percent), with concentrations ranging from 10 µg/kg to 640 µg/kg. For those concentrations that were detected in the in-River samples, 1,2-DCB levels were generally below 50 µg/kg (Figure 5-5). Exceptions included samples collected along Transects 23 and 24, which contained relatively higher concentrations. At Transect 23, concentrations up to 110 µg/kg were observed along the western side of the River (core 031). Similarly, samples collected at Transect 24 showed relatively higher concentrations along the western side of the River (core 037), with levels up to 640 µg/kg. As seen in Figure 5-5, most of the highest detected concentrations were found within the northern portion of the HRSA, primarily along the western side.

As depicted in Table 4-2, the highest mean detected concentration of 1,2-DCB was found in the 0- to 0.5-foot interval, with concentrations decreasing appreciably beyond this point (i.e., deeper in the sediment column). In fact, there were no detectable levels of 1,2-DCB found below 2 feet. The highest individual concentration of 640 µg/kg was found at the 0- to 0.5-foot interval (core 037).

Figure 5-5 shows Mudflat concentrations of 1,2-DCB generally below 40 µg/kg, with the maximum detected concentration (53 µg/kg) observed at Mudflat 9 (eastern side of the River).

5.1.2.2 1,3-Dichlorobenzene

1,3-DCB was detected in a small percentage of HRSA RI samples (15 percent), with concentrations ranging from 7.7 µg/kg to 2,700 µg/kg. For those concentrations that were detected in the in-River samples, levels were generally below 150 µg/kg (Figure 5-6). Exceptions included samples collected at Transects 21 and 24, which showed relatively higher concentrations. Specifically, Transect 21 showed concentrations up to 600 µg/kg along the eastern side of the River (core 030), while Transect 24 showed concentrations up to 2,700 µg/kg along the western side of the River (core 037). As shown on Figure 5-6, most of the highest detected concentrations were found within the northern portion of the HRSA, along both sides of the River.

As depicted in Table 4-2, the highest mean detected concentration of 1,3-DCB was found in the 0- to 0.5-foot interval, with concentrations decreasing appreciably beyond this point (i.e., deeper in the sediment column). In fact, there were no detectable levels of 1,3-DCB found below 2 feet. The highest individual concentration of 2,700 µg/kg was found at the 0- to 0.5-foot interval (core 037).

Concentrations of 1,3-DCB were generally below 60 µg/kg in Mudflat samples, with the maximum detected concentration (72 µg/kg) observed at Mudflat 10 (eastern side of the River).

5.1.2.3 1,4-Dichlorobenzene

1,4-DCB was detected in 32 percent of HRSA RI samples, with concentrations ranging from 9.4 µg/kg to 8,500 µg/kg. For those concentrations that were detected in the in-River samples, levels were generally below 300 µg/kg (Figure 5-7). Exceptions included samples collected along Transects 21, 23 and 24, which contained relatively higher concentrations. Similar to 1,3-DCB, Transect 21 showed concentrations up to 1,800 µg/kg on the eastern side of the River (core 030), and Transect 24 showed concentrations up to 8,500 µg/kg on the western side of the River (core 037). Additionally, Transect 23 showed concentrations up to 1,000 µg/kg at core 032. Once again, higher SVOC detected concentrations were generally found at the northern end of the HRSA, along both the eastern and western sides of the River.

As depicted in Table 4-2, the highest mean detected concentration of 1,4-DCB was found in the 0- to 0.5-foot interval, with concentrations decreasing appreciably beyond this point (i.e., deeper in the sediment column). In fact, there were no detectable levels of 1,4-DCB found below 4 feet. The highest individual concentrations were found at

core 037 in the 0- to 0.5-foot interval (8,500 µg/kg), core 030 in the 0- to 0.5-foot (1,800 µg/kg) and 0.5- to 2-foot intervals (1,400 µg/kg), and core 032 in the 0- to 0.5-foot interval (1,000 µg/kg).

Concentrations of 1,4-DCB were generally below 200 µg/kg in Mudflat samples. Similar to 1,3-DCB, the maximum detected concentration (270 µg/kg) was observed within Mudflat 10 (eastern side of the River). Mudflats 4 and 9 also contained a relatively elevated concentration of 210 µg/kg.

5.1.2.4 1,2,4-Trichlorobenzene

1,2,4-TCB was detected in a small percentage of HRSA RI samples (16 percent), with concentrations ranging from 23 µg/kg to 5,600 µg/kg. For those concentrations that were detected in the in-River samples, levels were generally below 1,000 µg/kg (Figure 5-8). Similar to the dichlorobenzene isomers discussed above (Sections 5.1.2.1, 5.1.2.2 and 5.1.2.3), exceptions included samples collected at Transects 21, 23 and 24, which contained relatively higher concentrations. Transects 21 and 23 showed relatively higher concentrations on the eastern side of the River (cores 030 and 032), with concentrations varying up to 3,200 µg/kg. Additionally, samples collected at Transect 24 contained concentrations up to 5,600 µg/kg along the western side of the River (core 037). As observed, higher detected concentrations were generally noted at the northern end of the HRSA, along both the eastern and western sides of the River.

As depicted in Table 4-2, the highest mean detected concentration of 1,2,4-TCB was found in the 0- to 0.5-foot interval, with concentrations decreasing appreciably beyond this point (i.e., deeper in the sediment column). In fact, there were no detectable levels of 1,2,4-TCB below 2 feet. The three highest individual concentrations were found in the 0- to 0.5-foot intervals at cores 037 (5,600 µg/kg), 030 (3,200 µg/kg) and 032 (3,100 µg/kg).

Concentrations of 1,2,4-TCB in Mudflat samples were generally below 100 µg/kg. Similar to 1,2-DCB, the maximum detected concentration (120 µg/kg) was observed in Mudflat 9 (eastern side of the River). Mudflats 4 and 10 also contained relatively elevated concentrations of 1,2,4-TCB.

5.1.2.5 Naphthalene

Naphthalene was detected in 59 percent of HRSA RI samples, with concentrations ranging from 14 µg/kg to 11,000,000 µg/kg. For those concentrations that were

detected in the in-River samples, levels generally decreased when progressing upriver along the HRSA (Figure 5-9). Some of the higher concentrations were found at Transect 5, Transect 7 and Transect 11. Specifically, concentrations observed at Transect 5 were detected up to 430,000 µg/kg along the western side of the River (core 005). At Transect 7, concentrations up to 150,000 µg/kg were observed along the eastern side of the River (core 008). Finally, Transect 11 showed relatively higher concentrations at both of the cored locations (011 and 012), with levels up to 11,000,000 µg/kg. As observed, the majority of the highest detected levels were found in the southern portion of the HRSA, along both the eastern and western sides of the River.

As depicted in Table 4-2, the highest mean detected concentration of naphthalene was found in the 0.5- to 2-foot interval. While mean detected concentrations generally decreased deeper into the sediment column, the second highest “mean” detected concentration occurred at the 8- to 10-foot interval (represented the only detection in this interval). The two highest individual concentrations were found at the 0.5- to 2-foot (11,000,000 µg/kg, core 012) and 0- to 0.5-foot (3,200,000 µg/kg, core 012) intervals.

Similar to in-River samples, concentrations of naphthalene in Mudflat samples generally decreased when moving upriver along the HRSA, with the maximum detected concentration (1,200 µg/kg) observed in Mudflat 2 (western side of the River).

5.1.2.6 Total PAHs

Total PAHs were detected in a relatively high percentage of HRSA RI samples (77 percent), with concentrations ranging from 13 µg/kg to 75,300,000 µg/kg. For those concentrations that were detected in the in-River samples, levels generally decreased when progressing upriver along the HRSA (Figure 5-10). Samples collected at Transect 11 showed the highest concentrations (up to 75,300,000 µg/kg) on the eastern side of the River (core 012).

As depicted in Table 4-2, the highest mean detected concentration of total PAHs was found in the 0.5- to 2-foot interval. Similar to naphthalene, mean concentrations generally decrease from this point (i.e., deeper in the sediment column), although isolated elevated concentrations were once again found in deeper intervals (e.g., 708,000 µg/kg noted in the 8- to 10-foot interval of core 005). The two highest individual concentrations were found at the 0.5- to 2-foot (75,300,000 µg/kg, core 012) and 0- to 0.5-foot (56,800,000 µg/kg, core 012) intervals.

Concentrations of total PAHs in Mudflat samples were generally below 45,000 µg/kg. Similar to 1,3-DCB and 1,4-DCB, the maximum detected concentration (47,600 µg/kg) was observed in Mudflat 10 (eastern side of the River). Mudflats 2, 4 and 6 also contained relatively elevated concentrations as compared to the remaining Mudflat locations.

5.1.2.7 SVOC Summary

Overall, SVOC detection frequencies were low in HRSA samples, with the exception of those constituents categorized as PAHs. In addition, detected concentrations of dichlorobenzene and trichlorobenzene isomers in both in-River and Mudflat samples were generally low, although relatively higher concentrations were consistently found along Transects 21, 23 and 24 in the northern portion of the HRSA. In contrast, detected concentrations of naphthalene and total PAHs generally decreased when moving upriver along the HRSA, with relatively higher concentrations found at Transects 5, 7 and 11. Finally, concentrations generally decreased with depth, with the maximum mean detected concentrations typically found in the surface of the sediment (0 to 0.5 feet). There were few detections below 4 feet. For the chlorinated benzene isomers, Mudflats 9 and 10 contained relatively higher concentrations as compared to other mudflats. Mudflats 2, 4, 6, and 10 were shown to be most affected by total PAHs and naphthalene. The overall mean concentration of in-River samples was also generally higher than that of Mudflat samples.

As shown in Table 5-2, mean detected RI concentrations of dichlorobenzene and trichlorobenzene isomers were more than 100 times greater than those found in historical sediment samples. Mean detected concentrations of naphthalene were approximately two times greater in the RI dataset. Finally, total PAH mean detected concentrations were generally five times greater in samples collected as part of the HRSA RI Program, than in historical samples.

5.1.3 Inorganics

The following subsections discuss trends for inorganics that have been identified as regional COIs, including total chromium, hexavalent chromium, total cyanide, lead and mercury. This discussion focuses on general observations as they relate to horizontal and/or vertical characterization trends.

5.1.3.1 Total Chromium

As indicated above, total chromium was detected in 100 percent of HRSA RI samples, with concentrations ranging from 5.5 mg/kg to 1,170 mg/kg. For those concentrations that were detected in the in-River samples, levels generally decreased when progressing upriver along the HRSA (Figure 5-11). As shown on Figure 5-11, samples collected in the two cores along Transect 5 (cores 005 and 006) contained total chromium concentrations that were up to approximately four times greater than those observed along most other transects. In addition, one sample collected at Transect 27 (core 035, 0.5- to 2-foot interval; western side of River) also showed concentrations approximately twice those observed along other transects. Overall, the highest concentrations were found within the southern portion of the HRSA, primarily along the western side of the River. With the exception of samples described above, total chromium concentrations were generally below 300 mg/kg.

As depicted in Table 4-3, the highest mean detected concentration of total chromium was found in the 2- to 4-foot interval, although mean concentrations within the sediment column are not appreciably different. The two highest individual total chromium concentrations were found at core 005 (1,170 mg/kg in the 0.5- to 2-foot interval and 750 mg/kg in the 2- to 4-foot interval).

Total chromium concentrations in Mudflat samples were generally below 200 mg/kg, with the maximum detected concentration (196 mg/kg) observed in Mudflat 2 (western side of the River). Mudflat 6 also exhibited elevated concentrations of total chromium as compared to the remaining four mudflat areas. As such, elevated levels were generally noted in mudflats located in the southern and western portion of the HRSA.

5.1.3.2 Hexavalent Chromium

Hexavalent chromium was detected in 43 percent of HRSA RI samples, with concentrations ranging from 0.34 mg/kg to 19.7 mg/kg. For those concentrations that were detected, levels were generally below 2.5 mg/kg (Figure 5-12). Relatively higher levels (between 12.9 mg/kg and 19.7 mg/kg) were found at Transect 5 (core 005) along the western side of the River. In addition, levels up to approximately twice those found at most other transects were noted at Transects 13 (core 13, 2- to 4-foot interval), 19 (core 28, 0.5- to 2-foot interval), and 21 (core 30, 0- to 0.5-foot interval), primarily along the eastern side of the River. Overall, the highest concentrations were generally found within the southern portion of the HRSA, with somewhat lower elevated concentrations

located further north. With the exception of those samples described above, hexavalent chromium concentrations were generally less than the SQL of 2 mg/kg.

For the samples noted above, with relatively higher levels of hexavalent chromium observed, it is noteworthy that the pH and ORP values indicates that the sample matrices are reducing in nature. Based on the demonstrated reducing environment, these samples should be incapable of sustaining hexavalent chromium in the +6 valence state. The positive detections reported for hexavalent chromium in these samples are inconsistent with the redox chemistry of the samples and may be anomalous or the result of interferences. In fact, low hexavalent chromium recoveries observed in the associated matrix spike analyses for these samples. The low hexavalent chromium recoveries were actually expected and were consistent with a reducing sample matrix (*i.e.* hexavalent chromium added as a spike to these samples were also reduced). Consequently, hexavalent chromium results reported in samples with demonstrated reducing conditions may not reflect actual field conditions and the trends may be coincidental.

As depicted in Table 4-3, the highest mean detected concentration of hexavalent chromium was found in the 0.5- to 2-foot interval. This is true when excluding the single detection of 12.9 mg/kg found in the 4- to 6-foot interval of core 005. Keeping with that exception, mean concentrations were generally higher in the top 2 feet of sediment and then decreased deeper into the sediment column.

Concentrations of hexavalent chromium were generally below 2 mg/kg in Mudflat samples, excepting concentrations observed along Mudflat 4 on the eastern side of the River (8.1 mg/kg and 6.2 mg/kg) and Mudflat 6 on the western side of the River (4.8 mg/kg). Consistent with this, and similar to the in-River samples, higher concentrations were found in the southern region of the HRSA and along both sides of the River. Hexavalent chromium was not detected in either Mudflats 1 or 2.

5.1.3.3 Total Cyanide

Unlike the inorganic COIs discussed previously, total cyanide was detected in a relatively small percentage of HRSA RI samples (15 percent), with concentrations ranging from 0.33 mg/kg to 8.3 mg/kg. For those concentrations that were detected, levels were generally below 1 mg/kg (Figure 5-15). Exceptions included samples collected at Transects 11 and 23, which contained relatively higher concentrations (up to 8.3 mg/kg). Transect 11 contained elevated concentrations along the eastern side of the River (8.3 mg/kg, core 012), while Transect 23 showed elevated concentrations on

the western side of the River (8 mg/kg, core 031). Similar to other constituents, the higher total cyanide levels were noted in the southern HRSA, and in this case, primarily along the eastern side.

As depicted in Table 4-3, the highest mean detected concentration of total cyanide was found in the 0.5- to 2-foot interval, with no detectable levels below 4 feet. Mean concentrations found in the sampling intervals between 0 and 4 feet were not appreciably different. The two highest concentrations were found in the 0- to 0.5-foot (8.3 mg/kg, core 012) and 0.5- to 2-foot (8 mg/kg, core 031) intervals.

Similar to in-River samples, concentrations of total cyanide in Mudflat samples were generally below 1 mg/kg (Figure 5-15), with only four total detectable concentrations noted. The two highest concentrations were found at Mudflat 1 (7.1 mg/kg) on the eastern side of the River, and Mudflat 6 (3.5 mg/kg) on the western side of the River. Both of these mudflats are located within the southern portion of the HRSA.

5.1.3.4 Lead

Lead was detected in 100 percent of HRSA RI samples, with concentrations ranging from 0.045 mg/kg to 709 mg/kg. In this case, levels generally decreased when progressing upriver along the HRSA (Figure 5-13). However, as shown on Figure 5-13, samples collected between Transects 3 and 7 (cores 003, 006 and 008) contained concentrations up to three and one-half times those found at most other transects. These relatively higher concentrations were observed along both sides of the River. Overall, the highest lead concentrations were detected in the southern HRSA, primarily along the eastern side of the River.

As depicted in Table 4-3, the highest mean detected concentration of lead was found in the 0- to 0.5-foot interval. Although not appreciably different, mean concentrations generally decreased from this point deeper into the sediment column. Three of the highest concentrations were found in the 0- to 0.5-foot (709 mg/kg at core 008 and 588 mg/kg at core 003) and 0.5- to 2-foot (555 mg/kg, core 006) intervals.

Similar to in-River samples, concentrations of lead in Mudflat samples generally decreased when progressing upriver along the HRSA. Consistent with this, the maximum detected concentration (373 mg/kg) was observed at Mudflat 1 (eastern side of the River), although Mudflat 2 (just opposite Mudflat 1) also contained relatively elevated levels.

5.1.3.5 Mercury

Mercury was detected in a high percentage of HRSA RI samples (98 percent), with detected concentrations ranging from 0.0000475 mg/kg to 21.5 mg/kg. For those concentrations that were detected, levels generally decreased when progressing upriver along the HRSA (Figure 5-14). Once again, the highest detections were noted at Transect 5 along the western side (core 005), with concentrations approximately three times that of most other samples. Overall, the higher levels of mercury were observed within the southern HRSA. In addition, while the highest levels were noted along the western side of the River, several samples along the eastern side also contained relatively elevated concentrations of mercury.

As depicted in Table 4-3, the highest mean detected concentration of mercury was found in the 4- to 6-foot interval. Despite this, mean concentrations were not appreciably different among the various depth intervals. The two highest concentrations were found at core 005 in the 2- to 4-foot (21.5 mg/kg) and 0.5- to 2-foot (21.4 mg/kg) intervals.

Concentrations of mercury in Mudflat samples were generally below 3 mg/kg. The maximum detected concentration (3.4 mg/kg) was observed in Mudflat 4 (eastern side of the River). Mudflats 2 and 6 also showed consistently elevated levels of mercury as compared to other sampled Mudflats.

5.1.3.6 Inorganics Summary

Overall, inorganic constituents were frequently detected in HRSA samples. Generally, inorganic COI concentrations in the in-River samples varied throughout the HRSA, although higher concentrations were noted primarily in the southern region (i.e., before the “S” bend) between Transects 3 and 11. For three of the five inorganic COIs assessed, core 005 (Transect 5) was shown to contain some of the highest detected levels. Several elevated concentrations were also observed at isolated locations between Transects 19 and 27, located further to the north. Additionally, concentrations generally decreased with depth, with the maximum mean concentrations typically observed in the top 2 feet of sediment. Mercury was the exception, with its highest mean found at the 4- to 6-foot interval. Of the inorganic COIs discussed, Mudflats 1, 2, 4 and 6 contained relatively higher concentrations as compared to the other Mudflats. The overall mean detected concentration of mudflat samples was higher than that of in-River samples.

As shown in Table 5-2, a comparison of the HRSA RI data to data previously collected by the PRG within the HRSA showed that mean detected concentrations of total chromium, hexavalent chromium and cyanide were at least two times greater in samples previously collected by the PRG. Mean detected concentrations of lead and mercury were less divergent when comparing the HRSA RI and data previously collected by the PRG.

5.1.4 PCBs

The following subsections discuss trends of total congener PCBs, which have been identified as a regional COI. The discussion focuses on general observations as they relate to horizontal and/or vertical concentration trends.

5.1.4.1 Total Congener PCBs

Congener PCBs were detected in 100 percent of HRSA RI samples, with total detected concentrations ranging from 8.94 pg/g to 27,500,000 pg/g. For those concentrations that were detected, levels throughout the HRSA were generally below 500,000 pg/g (Figure 5-16). However, samples collected at Transect 5 along the western side of the River (core 005) were shown to contain total congener PCB concentrations up to approximately five times those observed along most other transects. Samples obtained from the eastern side of Transect 19 (core 028) approached similar levels. While the highest PCB levels were found in the southern portion of the HRSA, total congener PCB concentrations varied throughout, with no observable longitudinal trends noted. The same holds true for comparisons of the eastern side versus the western side of the River.

As depicted in Table 4-5, the highest mean detected concentration of total congener PCBs was found in the 0- to 0.5-foot interval. Mean concentrations generally decreased from this point deeper into the sediment column, especially below 2 feet. The three highest individual concentrations were found at the 0.5- to 2-foot interval (2,610,000 pg/g, core 005), the 0- to 0.5-foot interval (2,270,000 pg/g, core 005) and the 0- to 0.5-foot interval (2,150,000 pg/g, core 028).

Concentrations of total congener PCBs in Mudflat samples were generally below 3,000,000 pg/g (Figure 5-16). Exceptions included samples collected from Mudflats 1 and 2, which contained relatively higher concentrations (15,500,000 and 27,500,000 pg/g, respectively). Existing along opposite sides of the River, both Mudflats 1 and 2 are located within the southern portion of the HRSA.

5.1.4.2 Total Congener PCB Summary

Overall, congener PCBs were detected in 100 percent of HRSA samples. Generally, total congener PCB concentrations varied throughout the HRSA, although the highest concentrations were noted in the southern HRSA, primarily at core 005. Several elevated concentrations (although not as high) were also noted further north along the eastern side of Transect 19 (core 028). Additionally, the maximum mean concentration was found in the 0.5- to 2-foot interval. Mudflats 1 and 2 were shown to contain relatively higher concentrations as compared to other mudflats. The overall mean detected concentration of total congener PCBs in Mudflat samples was more than 20 times higher than that of the in-River samples.

As shown in Table 5-2, a comparison of data previously collected by the PRG and the 2006 RI sediment data was conducted for total Aroclor PCBs. This comparison was made since historical sampling programs did not analyze for congener PCBs. The comparison concluded that, generally, mean detected concentrations of total Aroclor PCBs were approximately eight times higher in samples previously collected by the PRG than in samples collected as part of the HRSA RI Program.

5.1.5 Pesticides

The following subsections discuss total DDT, which has been identified to be of regional interest. The text focuses on general observations as they relate to horizontal and/or vertical trends.

5.1.5.1 Total DDT

As indicated above, total DDT was detected in 71 percent of HRSA RI samples, with concentrations ranging from 0.57 µg/kg to 5,600 µg/kg. For those concentrations that were detected, levels generally decreased when progressing upriver along the HRSA (Figure 5-17). Samples collected along the eastern side of Transect 11 (core 012) contained total DDT concentrations up to approximately 18 times those observed along most other transects. To a lesser extent, Transect 5 (core 005, located along the western side) also contained relatively higher concentrations. Overall, the highest total DDT concentrations were found within the southern region of the HRSA and along the eastern side of the River. However, other notable detections were found on the western side, as well.

As depicted in Table 4-6, the highest mean detected concentration of total DDT was found in the 0.5- to 2-foot interval. Mean concentrations below 2 feet decreased appreciably. The two highest individual concentrations were found at core 012 in the 0.5- to 2-foot (5,600 µg/kg) and 0- to 0.5-foot (1,400 µg/kg) intervals.

Similar to in-River samples, concentrations of total DDT in Mudflat samples generally decreased when progressing upriver along the HRSA (Figure 5-17). Samples collected from Mudflat 1 (on the eastern side of the River) and from Mudflat 6 (on the western side of the River) showed the highest levels of total DDT, varying up to 218 µg/kg (Mudflat 1). Both Mudflats 1 and 6 are located in the southern HRSA.

5.1.5.2 Pesticides Summary

Overall, pesticide constituents were detected at low to moderate frequencies throughout the HRSA. Total DDT concentrations in both the in-River and Mudflat samples generally decreased when progressing upriver along the HRSA. Concentrations generally decreased with depth as well, with the maximum mean concentration observed in the 0.5- to 2-foot interval. Mudflats 1 and 6 were shown to contain relatively higher concentrations as compared to other mudflats. The overall mean detected concentration of in-River samples was also approximately two times higher than that of Mudflat samples.

As shown in Table 5-2, a comparison of the HRSA RI data to sediment data previously collected by the PRG within the HRSA showed that mean detected concentrations of total DDT were approximately six times greater in samples collected as part of the HRSA RI Program.

5.1.6 Dioxins/Furans

The following subsections discuss trends for 2,3,7,8-TCDD, which has been identified as a regional COI. The discussion focuses on general observations as they relate to horizontal and/or vertical trends.

5.1.6.1 2,3,7,8-TCDD

2,3,7,8-TCDD was detected in a moderate percentage of HRSA RI samples (73 percent), with concentrations ranging from 0.113 pg/g to 2,990 pg/g. For those concentrations that were detected, levels were generally below 200 pg/g (Figure 5-18). Exceptions included samples collected along the western side of Transect 5 (core

005), which were shown to contain levels up to 15 times those observed along most other transects. Additionally, Transect 19 contained one sample collected from the eastern side of the River (core 028) that was approximately four times those observed elsewhere. Higher concentrations were once again found predominantly in the southern region of the HRSA, with isolated elevated levels detected further north.

As depicted in Table 4-7, the highest mean detected concentration of 2,3,7,8-TCDD was found in the 0- to 0.5-foot interval. From this point, mean concentrations progressively decreased through the sediment column. Appreciable changes were noted below 2 feet. The two highest individual concentrations were found at core 005 in the 0- to 0.5-foot (2,990 pg/g) and 0.5- to 2-foot (1,370 pg/g) intervals.

Concentrations of 2,3,7,8-TCDD in Mudflat samples varied throughout the HRSA, with most concentrations primarily below 125 pg/g (Figure 5-18). Exceptions included samples collected from Mudflat 4 on the eastern side of the River (310 pg/g), and Mudflat 2 (183 pg/g) on the western side of the River. Both mudflats are situated in the southern portion of the HRSA.

5.1.6.2 Dioxin/Furan Summary

Overall, dioxin/furan congeners were detected at moderate-to-high frequencies (i.e., greater than 58 percent) in HRSA samples. 2,3,7,8-TCDD concentrations in the in-River samples were generally below 200 pg/g throughout. However, relatively elevated concentrations were observed primarily in the southern HRSA, and on both sides of the River. The maximum mean concentration was found at the 0- to 0.5-foot interval. mudflats 2 and 4 were shown to contain relatively higher concentrations, as compared to other mudflats. The overall mean detected concentrations of in-River and Mudflat samples were not appreciably different.

As shown in Table 5-2, a comparison of the HRSA RI data to data previously collected by the PRG within the HRSA showed that mean detected concentrations of 2,3,7,8-TCDD were slightly greater in samples collected as part of the HRSA RI Program.

5.1.7 TOC/Organics

As part of the data assessment process, TOC data were compared with various organic constituents (including total DDT; 2,3,7,8-TCDD; total congener PCBs; naphthalene; and total PAHs) to determine whether any type of relationship existed. None of the comparisons displayed strong correlation patterns, apparently attributable

to the relative differences in concentration ranges. TOC concentrations ranged within three orders of magnitude, while the organic constituents ranged between 4 and 7 orders of magnitude. As such, this potential relationship was not pursued further.

5.2 Observed Trends in Sediments — Radiochemistry

For radiochemistry analyses, Pb-210, Be-7 and Cs-137 activity was measured at select locations throughout the HRSA. The purpose of these analyses was to assist in dating the sediment, and to help verify sediment deposition rates. Each parameter is discussed further below.

5.2.1 Beryllium-7

Be-7 is a natural fallout nuclide with a half-life of 53 days. This radionuclide produced by cosmic rays is present in both suspended matter and near-surface sediments if there has been recent deposition. Because of the short half-life, Be-7 is not expected to be detectable at depth. The Be-7 activity is reduced to 9 percent of its original value after 6 months and is reduced to less than 1 percent after 1 year. The measurement of Be-7 activity in sediment cores is generally used to evaluate recent sedimentation.

Six in-River grab surface samples were analyzed for Be-7 as part of the HRSA RI Program using gamma spectroscopy. Be-7 was detected in only one sample at a concentration of 0.69 pCi/g at location 005 (Transect 5). As such, it appears that minimal sedimentation had occurred within the HRSA within several months of the sampling activities.

5.2.2 Cesium-137

The Cs-137 radiodating technique used for the HRSA RI was based on the premise that Cs-137 was first associated with sediments deposited in 1954 as a result of fallout from atmospheric testing of large nuclear weapons beginning that year. The sediment horizon associated with this date is interpreted as those sediments where Cs-137 is first detectable.

Additionally, in cores with continuous and relatively rapid sediment accumulation, the maximum levels of Cs-137 can be associated with the years of peak fallout delivery (1963 to 1964). However, the analytical uncertainty associated with identifying the point of maximum activity is greater than that for identifying the point of first

measurable activity, making it difficult to assign the 1963 horizon to a specified depth. This is largely due to the fact that the onset of Cs-137 activity was a sharply defined event, where activity increased greatly in 1954 related to the onset of aboveground nuclear tests. The 1963 maximum is a much less sharply defined event.

A total of 57 in-River samples were analyzed for Cs-137 as part of the HRSA RI Program using gamma spectroscopy. Cs-137 was not detected in these samples. As such, the point of first measurable activity corresponding to the 1954 horizon and peak activity corresponding to the 1963 horizon could not be identified during this program. These observations are consistent with the Be-7 evaluation, indicating that the HRSA does not appear to be net depositional.

5.2.3 Lead-210

Pb-210 radiodating is based on two major assumptions. First, it is assumed that atmospheric contributions of Pb-210 to sediments as they are being deposited are constant through time and, therefore, a decrease in the concentration of Pb-210 will occur in buried sediments related solely to its radioactive decay. Thus, the Pb-210 concentration in sediment should decrease exponentially as a function of time, because radioactive decay follows first-order kinetics (the rate of decay is solely a function of the concentration of the Pb-210 present). The rate constant for Pb-210 decay is 3.11×10^{-2}/year.

Second, it is assumed that the rate of sediment deposition at a given location is constant through time. Therefore, the sediment depth is assumed to be a linear function of time of deposition. A sedimentation rate can be calculated from the slope of the line obtained by plotting the Pb-210 concentration as a function of sediment depth.

A plot of the logarithm of the activity as a function of time should theoretically be a straight line, with the line slope directly related to the rate of radioactive decay. A correction to the Pb-210 concentration is made for other natural contributions (background) from radioactive decay from elements for which it is a daughter product.

A total of 57 in-River samples were analyzed for Pb-210 as part of the HRSA RI Program. Pb-210 analyses were performed using beta detection methods. Pb-210 was

detected in 100 percent of samples, with concentrations ranging from 0.364 to 1.37 pCi/g.

A review of the Pb-210 data and the associated logarithm plots of the activity as a function of time did not show a line slope directly related to the rate of radioactive decay. This observation indicates that no apparent concentration patterns exist at the six locations sampled. These observations are consistent with both the Cs-137 and Be-7 evaluations, indicating minimal, if any, net deposition in the HRSA.

5.3 Geotechnical

A total of 122 samples were analyzed for grain size as part of the HRSA RI Program, representing approximately 98 percent of the total samples obtained during this investigation. As discussed in Section 4.3.1, results indicate that the in-River sediments are somewhat interchangeable between sand and silt, with the sandier matrix closer to the surface and the finer-grained materials at depth. Sediments become more distinctly fine grained at depths between 4 and 8 feet. The absence of gravels, and to a lesser extent clay, is not considered unusual. Gravels tend to settle out of suspension relatively quickly and are usually found closer to their point of origin. Extremely fine particulates like clays may remain in suspension for quite a long time, and are ultimately deposited in smaller increments over a larger area.

Results of the Mudflat sampling indicate that the majority of the coarse-grained particles settled prior to encountering this geomorphic area, as discussed in Section 4.3.1. Again, this is expected given that relatively shallow water depths don't possess the energy to maintain suspension of the heavier sand particles. In contrast, the finer-grained materials may remain in suspension in the shallow, slower moving water that would inundate the mudflat area. Thus, this area is shown to contain more fine-grained sediments.

As part of the overall assessment of these grain-size data, results were compared to TOC to determine whether a relationship existed. In this case, an identifiable trend or correlation was not identified.

5.4 Discussion of Data

As shown throughout this RI Report, the HRSA can be characterized as a multichemical site. To better understand the patterns and distribution of constituents described, it is important to refer to the preliminary CSM presented in the approved

HRSA RIWP (BBL, 2005a). This initial characterization of the HRSA was based on historical information obtained at that time, as well as observations developed as a result of the 2005 Reconnaissance Investigation Program.

The preliminary CSM described the Hackensack River as a unique system, considering its unusual geomorphic features and reduced freshwater flow. The creation of dams, diversion of water to various municipal water systems and historical dredging operations are just a few of the anthropogenic activities that have contributed to such conditions.

Geomorphically, the HRSA includes a large river meander; however, bathymetric data obtained during the 2005 Reconnaissance Program show that classical meander features are not entirely evident. For example, distinct point bar formations are not observed along the inside bends of the River. In addition, there are several deep channels located along the bends, characterized by water depths ranging between 40 and 55 feet that cannot be accounted for by historical dredging records.

Prior to this RI, sedimentation rates in the HRSA had not been extensively measured. However, using data from only two cores (one within and one north of the HRSA), Goeller (1989) estimated that the average long-term deposition rates in this lower region of the Hackensack River ranged from 0.39 in/yr to 1.2 in/yr. In comparison, the lower 6 miles of the Passaic River have been shown to deposit between 1.5 and 4 in/yr (Huntley, et al., 1995). Together with conditions described above, the relatively low deposition rates found in the HRSA are likely caused by a combination of several factors, including:

- relatively high tidal velocities (1.9 ft/sec at the mouth of the River [Marshall, 2004; Pence, 2004], and 2.6 ft/sec within the HRSA [Pence, 2004])

- lack of sediment supply to the system, possibly due to solids trapping behind dams and within the Meadowlands

- significant disruption of freshwater flow due to the presence of the Oradell Dam and a tidal prism extending up to the Meadowlands

From an analytical perspective, the majority of historical sediment sampling conducted with the HRSA occurred within close proximity of the Diamond and SCCC shorelines. A more recent sediment investigation was also conducted along the PSE&G Facility.

Historical analytical results indicated the presence of various constituents, including (but not limited to) metals, VOCs, SVOCs and pesticides/PCBs.

5.4.1 Updated CSM

Using the information obtained from the RI Program, the preliminary CSM is evaluated and updated herein. Because the HRSA RI focused only on sediments, the preliminary CSM can be revised only to the extent of describing constituent patterns and the potential cause for such observations.

Overall, it appears that the 2006 HRSA RI data are generally consistent with the preliminary CSM described in the approved HRSA RIWP (BBL, 2005a). First and foremost, the lack of usable radiochemistry data suggests that there is minimal long-term net deposition within the confines of the HRSA. This finding is generally consistent with Goeller (1989), who estimated relatively low deposition rates as compared to the lower Passaic River. Because the Cs-137 and Pb-210 RI data did not produce quantifiable information, sedimentation rates could not be calculated.

In essence, the HRSA appears to act as a conduit of water between Newark Bay and the upstream section of the River, with minimal solids fallout. What does deposit is mostly heavier in nature (i.e., sands), as shown by the RI surficial grain-size data. These sands (which can act as a surficial armoring layer) are also likely to be a result of the higher Hackensack River velocities, which tend to resuspend and transport whatever smaller fines may exist at the surface. While pockets of smaller sized, finer material do reside within the HRSA, the area as a whole is not considered to be a long-term depositional region.

As indicated, the RI Program identified the presence of multiple constituents along the HRSA. COIs found at detection frequencies greater than 90 percent included:

- mercury (98 percent)
- lead (100 percent)
- total chromium (100 percent)
- total congener PCBs (100 percent)

COIs detected between 50 percent and 90 percent included:

- naphthalene (59 percent)
- total PAHs (77 percent)
- total DDT (71 percent)
- 2,3,7,8-TCDD (73 percent)

In addition to the COIs, 71 constituents (as shown on Table 5-3) were also detected at frequencies greater than 75 percent. However, such constituents were not evaluated in this RI Report.

In general, with the exception of the chlorinated benzene isomers, detected COI concentrations tended to be greater along the southern stretch of the HRSA, primarily extending from Transect 5 to Transect 7. In particular, core 005 (total and hexavalent chromium, mercury, congener PCBs, 2,3,7,8-TCDD and naphthalene) and core 008 (benzene, ethylbenzene, lead and naphthalene), both located relatively close to shore, contained some of the highest concentrations. Mudflats 4 and 6, also located in this same stretch of the River, were also shown to contain relatively higher concentrations (depending upon the Mudflat) of total chromium, hexavalent chromium, mercury, total cyanide, total DDT and 2,3,7,8-TCDD.

In this same region of the HRSA, several other isolated areas contained relatively elevated levels of various COIs, including:

- Mudflat 1 (total cyanide, congener PCBs and total DDT)
- Mudflat 2 (total chromium, mercury, congener PCBs, 2,3,7,8-TCDD and naphthalene)
- core 011 (Transect 11) (benzene, toluene, ethylbenzene, xylene and naphthalene)
- core 012 (Transect 11) (benzene, toluene, ethylbenzene, xylene, total cyanide, total DDT, naphthalene and total PAHs)

From the southern HRSA boundary through Transect 11, most of the higher concentrations were limited to the upper 2 feet of sediment, particularly those

associated with SVOCs, total DDT, total congener PCBs and 2,3,7,8-TCDD. However, at core 005, several notable detections of various metals extended below this depth.

Considering the three “deep” (i.e., 12-foot) cores collected during the RI Program (005, 019, 036), core 005 clearly contained the highest concentrations overall. In fact, for cores 019 and 036, most results deeper than 2 feet were very low, or nondetect.

North of Transect 11, most COIs were found at relatively lower concentrations as compared to the southern HRSA. However, several isolated cores between Transects 19 and 24 were shown to contain concentrations of several COIs greater than those along other transects, including:

- core 028 (Transect 19) (hexavalent chromium, congener PCBs and 2,3,7,8-TCDD)
- core 030 (Transect 21) (1,3-DCB; 1,4-DCB; 1,2,4-TCB; and hexavalent chromium)
- core 001 (Transect 22) (ethylbenzene and xylene)
- core 031 and core 032 (Transect 23) (1,2-DCB; 1,4-DCB; 1,2,4-TCB; and total cyanide)
- core 037 (Transect 24) (1,2-DCB; 1,3-DCB; 1,4-DCB; and 1,2,4-TCB)

As seen on Figure 3-1, most of these cores are located relatively close to shore. Higher mean concentrations were predominantly found in the 0.5- to 2-foot interval. In addition, Mudflats 9 and 10, located in the northern HRSA region, contained some of the highest levels of chlorinated benzene isomers as compared to the remaining four mudflat areas.

Overall, in-River samples generally produced higher concentrations than Mudflat samples for most COIs. Total congener PCBs and inorganics proved to be the exceptions.

In updating the preliminary CSM, the RI analytical dataset provided useful insight into the nature and extent of contamination throughout the HRSA. Most COIs were detected at greater concentrations in isolated areas of the southern HRSA and, to a lesser extent, segregated regions further to the north. The higher concentrations were

predominantly located relatively close to shore and were limited to the top 2 feet of sediment.

The observation that the HRSA is nondepositional meshes well with the analytical findings presented. In such an environment, one would not expect to see, generally, higher concentrations deep in the sediment column. Similarly, any finer solids that may deposit will likely do so closer to the shoreline.

Considering the industrial setting of this Study Area, and the estuary as a whole, it is not surprising to find a significant presence of multiple constituents in the sediments. Further assessment of potential sources to the HRSA will assist in better understanding the analytical data generated.

In addition, the observations presented in this section mean little without a respective risk assessment. In this regard, Section 6 provides the results of a site-specific SLERA that will help to further guide the HRSA RI Program.

6. Screening-Level Ecological Risk Assessment

6.1 Introduction

This SLERA for the HRSA was developed pursuant to the requirements set forth in a memorandum from the NJDEP to the PRG dated November 23, 2005. The SLERA has been prepared according to the *SLERA Work Plan* (SLERA WP) (ARCADIS BBL, 2007), which was submitted in February 2007 as an addendum to the approved HRSA RIWP (BBL, 2005a).

The SLERA was conducted in accordance with regulatory requirements for ecological evaluations set forth in the N.J.A.C. at 7:26E-3.11 *et seq*. (Site Investigation – Ecological Evaluation). Under these guidelines, a BEE was required for the HRSA. The BEE is a screening process to determine the need to conduct further ecological risk assessment activities. The objectives of the BEE are to examine and screen existing data and information from the site for evidence of co-occurrence of constituents of potential concern, environmentally sensitive areas and a chemical migration pathway to any such sensitive areas. Per NJDEP guidance, this screening (i.e., BEE) follows the USEPA regulations and guidelines for risk assessment. As such, the BEE was conducted using the SLERA process as described in the USEPA's *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Interim Final* (1997).

6.1.1 Background

The HRSA (Figure 1-2) is approximately 2.7 miles in length, with the upper and lower boundaries located approximately one-half mile from the Diamond Site and the Seaboard Site, respectively. A detailed description of the area is provided in Section 2.3.2.

In May 2005, the PRG submitted the *Reconnaissance Investigation Report* (BBL, 2005b) for the HRSA to the NJDEP. This report contained results of the PRG's efforts to compile and review existing data for the HRSA, collect additional field data and information, and identify possible sources of contamination at the HRSA. One of the stated objectives of this report was to support the later development of a SLERA for the HRSA.

Additionally, the PRG submitted the HRSA RIWP (BBL, 2005) to the NJDEP in December 2005. Associated addenda were also submitted to the NJDEP in July and

October 2006, and the SLERA WP was submitted as a separate addendum in February 2007. The goal of the RIWP was to collect sediment data to determine the preliminary nature and extent of chemical constituents in HRSA sediments, and to conduct a SLERA. Sediment sampling associated with the approved HRSA RIWP (BBL, 2005a) was conducted from late October to early November 2006. Data were analyzed and validated, and have been summarized in the previous sections of this report. This section presents the screening of these data to determine if there is a potential for risks to ecological receptors posed by constituents detected in HRSA sediments.

6.1.2 Purpose and Scope

Per applicable USEPA (1997) guidance, a SLERA is a simplified risk assessment conducted to assess the need and the level of effort necessary to conduct a more detailed Baseline Ecological Risk Assessment (BERA) for the HRSA. To meet this objective, a conservative screening process is used to assess constituents of potential ecological concern (COPECs), remove those that are insignificant and identify those that could pose risks to ecological receptors (USEPA, 2001).

The data quality objectives (DQOs) and decision rules to meet the objectives for the SLERA, as identified in the approved HRSA RIWP (BBL, 2005a), include:

DQO 1. Preliminarily characterize (through sediment sampling) the nature of contamination within key ecological habitats, primarily mudflats and near-shore areas

- Are the current habitat data and information for the HRSA sufficient to delineate and characterize habitat types and identify the primary organisms (i.e., ecological receptors) that use those habitats?

- Does potential chemical contamination exist in the identified habitats and, if so, to what extent?

DQO 2. Estimate risks to key ecological receptors

- Does the potential exist for constituent-related risks to ecological receptors in one or more habitats of the HRSA based on a screening-level evaluation of the sediment data?

- If there are apparent risks identified by the SLERA, is a BERA warranted for the HRSA to further define and quantify risk?

These issues were addressed in this SLERA by:

1. developing a screening-level Problem Formulation (which includes a Pathways Analysis Report [PAR]) that describes the habitats and potential ecological (i.e., organism) exposures that may occur in the HRSA, based on knowledge obtained from existing studies and the habitat survey conducted as part of the Reconnaissance Program

2. comparing the available sediment contaminant data to available sediment quality guidelines and benchmarks as specified by the NJDEP (1998) or others, as specified in N.J.A.C. at 7:26E-3.11 *et seq*.

3. developing a conservative screening-level risk characterization that summarizes the potential exposures/exposure pathways to constituents in the HRSA and the results of the toxicity (i.e., sediment guidelines) screen, and provides an assessment of the uncertainties in this SLERA

These three tasks comprise the SLERA for the HRSA. The results of this SLERA will be used to determine if potential risks exist and if a BERA is warranted. In addition, it will help to identify data gaps and assess the need for future data collection to support a BERA (as required).

The use of conservative assumptions helps to provide that chemicals/habitats/sites that could pose an ecological risk are carried through the screening process and studied further in subsequent risk assessment activities (i.e., BERA). There are several potential decision errors that can be made in the risk assessment process, given the subjective nature and high uncertainty associated with the risk paradigm. As such, at the screening level, a conservative approach is taken to avoid Type II errors (i.e., false negatives). This helps to provide that existing risks will not be ignored in the process.

6.2 Screening-Level Problem Formulation

A Screening-Level Problem Formulation was developed to describe the environmental and ecological setting of the HRSA, ecological communities and potential receptors that inhabit the HRSA and pathways through which receptors may be exposed to constituents. As part of the Screening-Level Problem Formulation, a preliminary PAR

was developed to characterize the ecological habitats of the HRSA, identify the array of species that may use these habitats and select representative species from the food web for evaluation in the exposure and effects assessment of the SLERA. The characterization of constituents known or suspected to be in the HRSA was presented in detail in Sections 4 and 5 of this RI Report. These are discussed further in the context of the sediment screening process in Section 6.3.

6.2.1 Environmental Setting and Habitat Characteristics

The physical setting, site history, demography and land use characteristics of the HRSA are described Section 2 of this report and are described in greater detail in the approved HRSA RIWP (BBL, 2005a). Section 3 of this report provides further detail on the geomorphology, hydrodynamics, sediment transport processes and ecology of the HRSA as it relates to the development of a CSM. A graphical presentation of the HRSA CSM is presented on Figure 6-1. The conceptual model demonstrates how organisms at various levels of the food web may be exposed to constituents in the HRSA.

6.2.1.1 Habitat Characterization

Habitat characterization of the HRSA was achieved through the use of field results from the 2005 Reconnaissance Program, in addition to an evaluation of available literature and data. Various types of shoreline habitat within the HRSA identified during the Reconnaissance Program include old pilings, decaying wooden bulkheads, rock piles, mudflats and tidal marshes. Figure 2-2 shows locations of significant habitats and corresponding photographs. Approximate lengths of different shoreline types are presented in Table 2-1.

The mudflats located within the HRSA are of particular interest because they provide substrate for benthic organisms and foraging habitat for terrestrial animals. Twelve mudflats, ranging in length and width, were identified within the HRSA during the Reconnaissance Program (Figure 2-1). Sewer, CSO and industrial outfalls are of interest, as they constitute potential sources of water and constituents. Seven permitted outfalls were identified in the HRSA through reviews of public records and an additional nine open pipe outfalls (as well as four other outfalls with tide gates) were located during the Reconnaissance Program. Locations of all identified outfalls and tide gates are shown together with locations of mudflats on Figure 2-2.

6.2.1.2 Environmentally Sensitive Areas

Environmentally sensitive areas (ESAs) were identified using the results of the Reconnaissance Program and review of available literature and data. Table 6-1 lists the ESAs identified in N.J.A.C. 7:1-1.8 and notes their presence or absence in the HRSA. The following subsections summarize the occurrence of each type of ESA in the HRSA.

Surface Waters/Estuarine Areas

The portion of the Hackensack River containing the HRSA is classified as an SE2 surface-water body by N.J.A.C. 7:9B Surface Water Quality Standards. As defined in N.J.A.C. 7:9B-1.12, SE2-classified water bodies are saline estuarine waters with the following designated uses:

- maintenance, migration and propagation of the natural and established biota
- migration of diadromous fish
- maintenance of wildlife
- secondary contact recreation
- any other reasonable uses

The setting and watershed description for this surface-water feature are presented in Section 2 of this report. The U.S. Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) classifies the Hackensack River located within the HRSA as E1UBL, which indicates that it is an estuarine system with an unconsolidated bottom and permanently flooded substrate.

Wetlands and Wetland Transition Areas

The USFWS NWI was used to identify wetlands areas adjacent to the boundaries of the HRSA. Figure 6-2 presents the NWI map showing the HRSA. Classifications and areas of the wetlands located adjacent to the HRSA are presented in Table 6-2. These include estuarine and marine wetlands, and freshwater emergent and shrub wetlands, and ponds.

Breeding, Migratory and Wintering Areas

As part of the Hackensack Meadowlands Complex, the intertidal mudflats and impoundments of the HRSA may serve as important habitats for shorebirds, both in spring and fall migrations, and for wintering and summering waterfowl (USFWS, 1997). A wide variety of bird species were observed in the HRSA during the 2005 Reconnaissance Program. Also observed were small mammals such as muskrat, raccoon and Norway rat, which likely live and breed in the HRSA. A checklist of the species that were observed is provided in Table 2-2.

Finfish Migratory Pathways

Finfish migratory pathways are waterways that serve as passageways for diadromous fish during movement to or from seasonal spawning areas. Diadromous fish travel between salt and fresh water to spawn and can be either anadromous, living primarily at sea but migrating up rivers to spawn, or catadromous, living primarily in lakes, ponds and rivers but migrating out to sea to spawn. According to the USFWS (1997), the Hackensack River and its marshes regularly support 34 species of fish and provide important nursery habitat for both anadromous and marine species. Anadromous species using the Hackensack and its marshes include alewife (*Alosa aestivalis*), blueback herring (*Alosa pseudoharengus*), American shad (*Alosa sapidissima*), Atlantic tomcod (*Microgadus tomcod*) and striped bass (*Morone saxatilis*). Marine species that also use the Hackensack as a forage and/or nursery area include Atlantic menhaden (*Brevoortia tyrannus*), bluefish (*Pomatomus saltatrix*), weakfish (*Cynoscion regalis*) and winter flounder (*Pleuronectes americana*). The HRSA likely serves as an important migratory pathway to many or all of these species.

Threatened and Endangered Species Habitat

A request was submitted to the New Jersey Natural Heritage Program (NHP) Database to identify state or federal threatened or endangered species located within the area surrounding the HRSA. The full results of this search are provided in Appendix G. According to these results, the HRSA and/or surrounding area provide habitat for two state-listed endangered species: peregrine falcon (*Falco peregrinus*) and pied-billed grebe (*Podilymbus podiceps*). The American coot (*Fulica americana)* is also located in the HRSA and/or surrounding area and is ranked as a species in decline. The results of the database search indicate that the HRSA may be part of a coastal heron rookery, which has a state ranking of rare and a global ranking of possibly in peril. The HRSA was also reported to provide colonial water bird foraging habitat.

6.2.2 Potential Ecological Receptors

6.2.2.1 Species Potentially Occurring in the HRSA

Potential ecological receptors in the HRSA were identified through a wildlife survey conducted during the 2005 Reconnaissance Program and through review of available literature on the ecological communities in the Hackensack River and Meadowlands area. The wildlife survey conducted during the Reconnaissance Program included observing wildlife from a boat, identifying species (or lowest possible taxa) and recording the habitat type in which each wildlife species was observed. Results of this survey are provided in Table 2-2. Bird species observed included resident wetland-associated nesting birds such as the red-winged blackbird (*Agelaius phoeniceus*), waterfowl species such as the Canada goose (*Branta canadensis*) and American black duck (*Anas rubripes*), wading birds such as the black-crowned night-heron (*Nycticorax nycticorax*) and the great blue heron (*Ardea herodias*), and birds of prey such as osprey (*Pandion haliaetus*) and red-tailed hawk (*Buteo lineatus*). Mammal observations included muskrat (*Ondatra zibethica*), raccoon (*Procyon lotor*) and Norway rat (*Rattus norvegicus*).

Additionally, the USFWS (1997) identified many wildlife and aquatic species occurring in the Hackensack River and Meadowlands area. They note that the intertidal mudflats and impoundments in the Meadowlands are important habitats for thousands of shorebirds during spring and fall migrations, and for wintering and summering waterfowl.

The most abundant waterfowl species noted in the Meadowlands were Canada goose, American black duck, mallard (*Anas strepera*) and canvasback (*Athya valisneria*). The most abundant shorebird species found during a survey at the nearby Kingsland impoundments were semi-palmated sandpiper (*Calidris pusilla*), lesser yellowlegs (*Tringa flavipes*), short-billed dowitcher (*Limnodromus griseus*) and dunlin (*Calidris alpine*). Kearny Marsh was found to support populations of breeding water birds such as pied-billed grebe (a state endangered species per the NHP database), least bittern (*Lxobyychus exilis*) and black-crowned night-heron, as well as common moorhen (*Galinulla chloropsus*), herons, egrets and ibises.

The USFWS (1997) noted that breeding water bird and waterfowl species in the Meadowlands include Canada goose, mallard, American black duck, gadwall (*Anas strepera*), green-winged teal (*Anas crecca*), blue-winged teal (*Anas discors*), ruddy duck (*Oxyura jamaicensis*), pied-billed grebe, American coot (a declining species in

this portion of New Jersey according to the NHP), common moorhen, black-crowned night-heron, yellow-crowned night-heron (*Nycticorax violaceus*), least bittern, American bittern (*Botaurus lentiginosus*) and green heron (*Butorides striatus*). Several owl and hawk species are also noted to exist in the area, including northern harrier (*Circus cyaneus*), rough-legged hawk (*Buteo lagopus*), red-tailed hawk, American kestrel (*Falco sparverius*), short-eared owl (*Asio flammeus*) and long-eared owl (*Asio otus*). These species prey on small mammals including house mouse (*Mus musculus*) and meadow vole (*Microtus pensylvanincus*).

According to USFWS (1997), the most abundant fish in the Meadowlands portion of the Hackensack River and marshes is the mummichog (*Fundulus heteroclitus*), which reportedly makes up approximately 90 percent of fish caught in trawls and traps. Additional resident fish include striped killifish (*Fundulus majalis*), inland silverside (*Menidia beryllina*), Atlantic silverside (*Menidia menidia*), white perch (*Morone americana*), brown bullhead (*Ameiurus nebulosus*), white catfish (*Ameiurus catus*), carp (*Cyprinus carpio*), pumpkinseed (*Lepomis gibbosus*), bay anchovy (*Anchoa mitchilli*) and the catadromous American eel (*Anguilla rostrata*). As discussed in Section 6.2.1.2., many anadromous and marine fish species also use the river and its marshes.

The USFWS (1997) also report several species of epibenthic invertebrate species in the Meadowlands area including white-fingered mud crab (*Rhithropanoepus harrisii*), mysid shrimp (*Neomysis americana*), sand shrimp (*Crangon septemspinosa*), grass shrimp (*Palaemonetes pugio*) and several species of amphipods. Blue crab (*Callinectes sapidus*) is also reported to be common in the lower reaches of the River. Fifty-three species of benthic invertebrates were reported, of which 36 percent were polychaetes, 15 percent were mollusks and 11 percent were amphipods.

6.2.2.2 Sensitive Species

The presence of federally or state-listed threatened/endangered species or species of special concern was also assessed. Results of the New Jersey NHP Database search were used to identify threatened or endangered species that may occur within the HRSA (see Appendix G). As discussed in Section 6.2.1.2, the HRSA and/or surrounding area is home to peregrine falcon and pied-billed grebe, which are state-ranked endangered species. The American coot is also state-ranked as a species in decline.

6.2.3 Assessment and Measurement Endpoints

Assessment endpoints are defined as “explicit expressions of the actual environmental value that is to be protected, operationally defined by an ecological entity and its attributes” (USEPA, 1998). In the HRSA there are two critical concerns around which assessment endpoints were formulated: direct toxicity to animals from exposure to chemicals in sediments and indirect toxicity of bioaccumulative chemicals via trophic transfer (i.e., animals eating other contaminated animals) through the food web. For bioaccumulative chemicals (e.g., pesticides, PCBs, PCDD/Fs, mercury), the assessment endpoints for risk assessment should focus on fish and wildlife at middle to high trophic levels in the food web (e.g., crabs, fish, piscivorous birds, mammals). These consumer organisms tend to have the greatest susceptibility to adverse effects from exposure to such compounds because, theoretically, they can accumulate relatively large concentrations of chemicals from the variety of animals they eat. This phenomenon of increasing bioaccumulation with increasing trophic level in a food web is termed biomagnification. The level of biomagnification that occurs is highly site specific, and depends on the range of factors that control the bioavailability of chemicals from sediments into the food web, and exposure.

The selected assessment endpoints for the HRSA, based on our assessment of the existing ecological data for the area and the identified receptors of concern, include:

- survival and maintenance of a normally functioning benthic invertebrate community
- survival and maintenance of healthy, reproducing populations of epibenthic invertebrates (e.g., crustaceans, shrimp)
- survival and maintenance of healthy, reproducing populations of fish
- survival and maintenance of healthy, reproducing populations of piscivorous birds
- survival and maintenance of healthy, reproducing populations of piscivorous mammals

If the outcome of the assessment suggests that these assessment endpoints could be threatened by the presence of one or more groups of chemicals within the HRSA, then they are considered potentially “at risk.” The USEPA (1997) suggests formulating risk hypotheses and risk questions to be addressed by the risk assessment process. For the HRSA SLERA, the risk hypotheses/questions can be stated as:

- *Benthic invertebrates are directly exposed to multiple chemicals in sediments of the HRSA. Toxicity from these chemicals can depress the diversity and abundance of organisms that make up the benthic community. Do the available data suggest that acute and/or chronic toxicity to benthic invertebrates from one or more chemicals could be occurring? If so, where are these risks occurring and at what magnitude?*

- *Fish and crabs using the HRSA may be bioaccumulating chemicals from sediment and/or food sources. Exposure occurs primarily through consumption of contaminated food (prey). Do the available data suggest that HRSA-related chemicals are being accumulated in fish and crabs to concentrations where adverse reproductive effects could occur? If so, where within the HRSA are these risks likely to occur and are these risks significant from a population perspective?*

- *Piscivorous birds from colonies within the Hackensack Meadowlands and/or other habitats near the HRSA may be bioaccumulating chemicals from food (prey) sources in the HRSA. Do the available data suggest that HRSA-related chemicals are being accumulated in piscivorous birds to concentrations where adverse reproductive effects could occur? If so, where within the HRSA are these risks likely to occur, and are these risks significant from a population perspective?*

- *Piscivorous mammals from within the Hackensack Meadowlands and/or other habitats near the HRSA may be bioaccumulating chemicals from food (prey) sources in the HRSA. Do the available data suggest that HRSA-related chemicals are being accumulated in piscivorous mammals to concentrations where adverse reproductive effects could occur? If so, where within the HRSA are these risks likely to occur and are these risks significant from a population perspective?*

These risk hypotheses give focus to the issues that need to be addressed in the overall environmental risk assessment process for the HRSA, and provide a means for determining if enough information is available in the SLERA to address the DQOs and decision rules presented in Section 6.1.2.

6.3 Screening-Level Exposure and Effects Assessments

Risk is a function of exposure and toxicity. For a SLERA, existing data and information are used to determine what types of organisms are likely present at a site that may be exposed to contaminants. The toxicity assessment then screens the existing constituent data to determine if the concentrations are present at sufficient levels to potentially be a risk to these receptors. This section presents the approach that was used to conduct the screening-level exposure and effects (toxicity) assessment for the HRSA. Because the existing data for the Site are limited to chemical constituent data for sediments and the ecological information gathered during the reconnaissance phase of the project, these data will form the basis for the exposure and effects assessments, as well as the resulting screening-level risk characterization.

6.3.1 Screening-Level Exposure Estimates

An exposure pathways analysis, which is a detailed characterization of existing data and information on receptors and habitats in the HRSA, was performed. This analysis was used to identify and document the presence of active and complete exposure pathways on site. From this analysis, the ecological (exposure) components of the current conceptual model for the HRSA were developed.

The CSM is a simplified diagram that demonstrates the hypothetical links between the constituents in sediments and biota. It is used as a planning tool to identify the exposure pathways, ecological receptors and potential effects on which to focus the ecological risk assessment. The conceptual site food web model shown on Figure 6-1 illustrates the potential exposure pathways for contaminants in sediments of the HRSA based on the data and information assessments that have been conducted on the project to date.

The types of organisms that are present and likely exposed to contaminants in sediments or the food web at the HRSA were documented in Section 6.2.1.1. From this list, the categories of organisms and mechanisms of exposure (i.e., complete pathways) were categorized and a set of screening-level assessment endpoints was developed in Section 6.2.3. These include direct exposure to contaminants in sediments and water, and indirect exposure through ingestion of contaminated prey. Based on the existing data, the primary types of organisms that are exposed at the HRSA include benthic invertebrates (i.e., infauna), epibenthic invertebrates (e.g., crustaceans, shrimp), forage and predatory fish at different trophic levels, and piscivorous birds and mammals. Because many of the constituents that exist in

sediments within the HRSA can bioaccumulate/biomagnify in the food web, the most significant route of exposure is ingestion of contaminated prey. This exposure pathway is complete for organisms that obtain their food (e.g., fish and invertebrates) from the HRSA.

6.3.2 Screening-Level Ecological Effects Evaluation

A list of COPECs was developed by screening the detected constituents in the HRSA to determine which chemicals are actually of concern based on their detection frequency, bioaccumulation potential and toxic potential. The data collected to date for constituents detected in sediments from the HRSA were compiled, summarized and screened to evaluate their potential toxicity to benthic organisms, and for their potential to bioaccumulate and affect organisms at higher trophic levels in the aquatic food web. The screening process consists of the following six steps:

1. data compilation and summarization

2. consolidation of data for chemical compounds with similar modes of toxicological activity

3. analysis of the detection frequency in sediment and biota samples

4. comparisons of HRSA surface sediment concentrations (i.e., 0- to 0.5-foot in depth) to proposed marine/estuarine sediment quality guidelines or benchmarks

5. determination of the bioaccumulative potential of the chemicals

6. evaluation of the potential bioavailability of divalent metals using AVS/SEM metals data from the HRSA

The final step in the screening process was conducted to provide perspective on the potential limitations of metals availability in sediments within the HRSA. It was not used to exclude metals from the COPEC list if they exceeded their respective lowest effects level (LEL) values. Results of the AVS/SEM analysis are discussed further in the risk characterization. This screening process is consistent with guidelines set forth in the USEPA's ecological risk assessment guidance (USEPA 1997; 1998) and the NJDEP's *Guidance for Sediment Quality Evaluations* (NJDEP 1998).

6.3.2.1 Data Compilation and Summarization

The data compilation and review for chemicals constituents in the HRSA is presented in Sections 4 and 5 of this RI Report. Specific summaries of the surface sediment (i.e., 0 to 0.5 foot depth) data were also conducted for use in this SLERA. These include the following areas/habitats of the HRSA:

- all surface sediment samples (River and intertidal mudflats)
- intertidal mudflat surface sediment samples only
- River surface sediment samples only

The screening assessment for sediment constituents was performed for each of these areas to compare and contrast resulting COPEC lists for each. The analysis was limited to surface sediment samples, as this represents the biologically active zone (BAZ) where benthic organisms typically reside in the sediments and higher trophic level organisms forage.

For the purposes of the SLERA, results that were nondetect were assigned a concentration value of one-half the analyte-specific SQL. This was done to conservatively account for the possibility that a chemical constituent may be present at concentrations below the sample-specific detection limit. For the SLERA process, this approach is appropriate to limit the possibility of Type II errors in assessing the constituent data. However, in many instances, this greatly overstates the concentration of given constituents, particularly in the SVOC class, where the SQLs were substantially elevated above many of the detected concentrations of these compounds in the HRSA (see Section 5.1.2), and where individual compounds were consolidated (i.e., summed) into groups (see Section 6.3.2.2). This phenomenon is considered further in the interpretation of the screening results.

6.3.2.2 Consolidation of Chemical Groups

As a next step in the screening process, individual analytes/congeners from chemical groups with similar modes of toxicological activity were combined and summed to get total concentrations for that group. These include PAHs, PCBs and PCDDs/PCDFs. The individual PAHs were consolidated into three groups: low molecular weight PAHs (L-PAHs), high molecular weight PAHs (H-PAHs) and total PAHs. The individual Congener PCBs were combined to get a total PCB mass using the method prescribed

by the USEPA (1998). The 2,3,7,8-substituted PCDD/PCDF congeners were converted to their 2,3,7,8-TCDD equivalent concentration and summed as a group using the toxicity equivalence approach described in Van der berg, et al. (1998).

6.3.2.3 Analysis of Detection Frequency

The USEPA (1997) states that chemicals that are infrequently detected can be considered as candidates for elimination from the quantitative risk assessment because they "may be artifacts in the data due to sampling, analytical, or other problems, and therefore may not be related to site operations or disposal practices." On this basis, chemicals that were detected at a frequency of less than 10 percent in sediment samples from the HRSA were eliminated as COPECs. Sediment data for chemicals that were detected in greater than 10 percent of the HRSA samples will be carried through the rest of the screening process.

6.3.2.4 Sediment Quality Guidelines Screening

Available data for sediments in the HRSA were screened against existing sediment quality guidelines (SQGs) pursuant to NJDEP guidance. As prescribed by N.J.A.C. 7:26E-3.11, the references that were used to obtain applicable screening values will include, but not be limited to the following:

- *Guidelines for the protection and management of aquatic sediment quality in Ontario* (Persaud et al., 1993)

- *Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments* (Long, et al., 1995)

- *Briefing Report to the EPA Science Advisory Board on the Equilibrium Partitioning Approach to Generate Sediment Quality Criteria* (USEPA, 1989)

In addition, as directed by NJDEP's *Guidance for Sediment Quality Evaluations* (NJDEP, 1998), the following references were consulted to obtain screening values for volatile organics in sediment:

- *The development of Canadian marine environmental quality guidelines* (MacDonald et al., 1992)

The sediment data collected from the HRSA were compiled, summarized and compared to these SQGs. Per USEPA and NJDEP guidance, the maximum constituent concentration data were screened against the LEL to assess the most conservative scenario for exposures to contaminants within each habitat and for the HRSA as a whole. For perspective, upper effects level (UEL) values (from the same set sources of guidelines/benchmarks) were also included in the screen to determine those constituents that exceeded less conservative guidelines, in addition to the LEL. The available SQGs that were compiled and used in this SLERA are provided in Table 6-3. The sediment screen process and results are presented in Tables 6-4, 6-5 and 6-6.

6.3.2.5 Bioaccumulative Potential

The SQGs do not consider the potential bioaccumulation of chemicals in aquatic food webs and potential toxic effects to organisms higher than benthic invertebrates, such as fish, birds and mammals. In addition, there are no known data available on bioaccumulation of contaminants in the HRSA. For these reasons, contaminants that were detected in surface sediment were evaluated for their bioaccumulative potential. To accomplish this, the detected constituents were compared to a list of "Important Bioaccumulative Chemicals" (IBCs) as defined by the USEPA (USEPA, 2000). Those that are on this list were retained as COPECs based on their potential to pose bioaccumulative (i.e., food web ingestion-based) risks. The results are presented in Tables 6-4, 6-5, and 6-6.

6.4 Screening-Level Risk Characterization

The screening-level risk characterization compiles and assesses the results of data/information collected in the Problem Formulation/PAR and the screening-level exposure and effects assessments, and provides perspectives on the potential for risk in the HRSA. In a typical screening-level risk characterization, preliminary risk calculations (e.g., hazard quotients/hazard indices) would be made using existing data on chemical constituents in ecological receptors (i.e., bioaccumulation/tissue data) and relevant conservative toxicity reference values (TRVs). Subsequent food web modeling for higher trophic-level receptors would also be performed to estimate potential bioaccumulative risks.

Because there are no data on chemical constituents for organisms at any level of the food web in the HRSA, it is not possible or credible to preliminarily estimate bioaccumulative risks. As such, this risk characterization is based solely on the results

of the sediment screening process, which includes conservative components to establish a list of COPECs based both on direct toxicity (i.e., direct exposure to contaminated sediments) and indirect exposure (i.e., ingestion of contaminated prey in the food web, potentially resulting in bioaccumulation/biomagnification). Because the sediment screen captures the bioaccumulative COPECs as well as the SQG-based COPECs, it is conservative in determining the existing potential for risk.

6.4.1 Evaluation of Co-Occurrence of Contaminants and Habitats/Receptors

The objectives of the SLERA and BEE process are to examine and screen existing data and information from the HRSA for evidence of co-occurrence of COPECs, environmentally sensitive areas and a chemical migration pathway to any such sensitive areas. The conceptual model depicts the fate and transport mechanisms and exposure pathways for the HRSA. The sediment data that were collected for this RI (see Sections 4 and 5, and Tables 6-4, 6-5, and 6-6) demonstrate the widespread occurrence of several contaminants in the HRSA. It is likely that many of these constituents are due to sources outside of the HRSA, given the industrial nature of this portion of the NY/NJ Harbor Estuary (i.e., Newark Bay and its tributaries) and the fact that it is a tidal estuarine system. In addition, the types and levels of these constituents are similar to those that have been reported throughout the Newark Bay system (Tierra, 2004).

Tables 6-1 and 6-2 depict the ESAs and habitats that occur within the HRSA, respectively, and Section 6.2.2.1 discusses the potential receptors in those habitats. The HRSA is part of the Hackensack Meadowlands system, an area with a substantial amount of aquatic and wetlands habitat. The ESAs that are present represent portions of the larger Meadowlands' habitats. The sediments of these habitats in general, and likely the food webs that occupy or use these habitats, are contaminated from a variety of sources in this system, most of which are outside of the HRSA. For screening purposes, it is clear that there is a co-occurrence of COPECs, habitats and ESAs in the HRSA (and beyond). As such, the sediment screen to determine the potential for risk to ecological receptors from COPECs in this system is appropriate.

6.4.2 Chemicals of Potential Ecological Concern

Tables 6-4, 6-5, and 6-6 present the process and results of the sediment screen for the HRSA (as described in Section 6.3.2). A matrix of the final list of COPECs that were identified from the screen for the three sediment datasets that were investigated — in-River surface sediment, mudflat surface sediment, and all surface sediments combined

— is presented in Table 6-8. The identified COPECs include 18 inorganics/metals, dioxin/furans (assessed collectively as 2,3,7,8-TCDD toxicity equivalents [TEQs]), PCBs (assessed as total PCBs and 2,3,7,8-TCDD TEQs), 18 pesticides, 26 SVOCs (including 18 PAHs) and five VOCs. Nearly all of these constituents were retained as COPECs in the datasets for each of the three areas assessed (Table 6-7). There were very few differences in the list between sediment samples collected in mudflats and in-River. As such, results for the combined surface sediment samples category in Table 6-7 represents the COPEC list for the HRSA.

A substantial number of constituents (particularly volatile and semivolatile compounds) listed in Tables 6-4, 6-5, and 6-6 were screened out (i.e., were not retained as COPECs) based on a detection frequency in HRSA sediments of less than 10 percent. The remaining contaminants were retained as COPECs due primarily to exceedance of the LEL screening value by the maximum sediment concentration and/or being categorized by the USEPA (2000) as an IBC. Several inorganic chemicals (aluminum, antimony, barium, beryllium, cobalt, cyanide, iron, manganese, thallium and vanadium) were retained as COPECs based solely on the fact that a screening value does not exist. This was not the case for most of the organic compounds that were retained as COPECs.

In addition to providing the most conservative screen by comparing the maximum sediment concentration to the LEL for each constituent, Tables 6-4, 6-5, and 6-6 also provide data on the mean concentration for each contaminant and the UEL (as identified in Table 6-3). While the use of the LEL is appropriate for a conservative screen, these values typically represent the lowest possible thresholds of effects that have been seen and are not indicative of more typical levels that may cause effects. The UEL represents a somewhat less conservative threshold that is typically associated with the mid-range of effects that have been seen in the datasets from which the screening guidelines are generated. As such, they help to provide a bit more perspective on the potential likelihood that some effect(s) may occur from a given constituent. Similarly, while the maximum concentrations of contaminants are used in the conservative screen, it is the mean concentrations that more accurately represent the average concentrations to which ecological receptors may be exposed.

The sediment concentration data in Tables 6-4, 6-5, and 6-6 contain a shading pattern to depict the exceedance of either or both of the LELs and UELs for each contaminant that exceed at least one of these guidelines. This assessment is presented to provide perspective on the screening process and to determine if, on average, some constituents may be of more concern than others in the HRSA.

For instance, in Table 6-4 (screening of all surface sediment samples from the HRSA combined), there are eight metals whose maximum concentration exceed both the LEL and UEL. All but silver also have mean concentrations that exceed the LEL. However, only mercury has a mean concentration in sediments that exceeds both the LEL and UEL. This suggests that mercury is the metal of primary concern in this system. This is not surprising given the well-known upstream sources of mercury and the history of mercury pollution in the Hackensack Meadowlands.

Similarly, for organic compounds, there is a more limited list of compounds whose maximum and/or mean concentrations exceed both the LEL and UEL. Those whose mean concentration exceeds the UEL include a more limited group of pesticides such as DDT (and its derivatives DDE and DDD) and Endosulfan I and II; SVOCs such as dichlorobenzenes, bis(2-ethylhexyl)pthalate and various PAHs; and two VOCs, acetone and carbon disulfide. Many of these compounds are ubiquitous in the Hackensack River and NY/NJ Harbor Estuary in general.

Finally, Table 6-8 summarizes the results for AVS/SEM in sediment samples collected from the HRSA. These results provide some perspective on the potential bioavailability of the divalent metals — cadmium, copper, lead, nickel, silver and zinc in HRSA surface sediments. The ratio of total SEM (SEM_T) to AVS was calculated per USEPA (2002) guidance. The range of $(SEM_T – AVS)/f_{oc}$ was also calculated by geomorphic unit for the HRSA. As shown in Table 6-8, the results suggest that there is enough AVS in most of the surface sediments from the HRSA to bind the divalent metals and render them nontoxic. In addition, the high level of AVS in sediments from the HRSA may be sufficient to bind other metals such as chromium and mercury (USEPA, 2002). This assessment suggests that metals bioavailability should be considered in any further risk assessment/management evaluations that are conducted for the HRSA beyond this SLERA.

6.4.3 Uncertainties Assessment

There are a substantial number of uncertainties associated with the SLERA process. Most center around limited data and the compounded conservatism built into the exposure and effects portions of the process. However, per NJDEP and USEPA guidance, the SLERA process is geared toward being as conservative as possible to avoid Type II errors (i.e., false negatives) when assessing the need for further risk assessment at a site. As such, the results of the conservative screen are useful for their intended purpose (i.e., determining if there are constituents present at levels that could pose risk to one or more ecological receptors at the HRSA). The only definitive

conclusions that can be drawn from the SLERA (regarding risks) is that those constituents that are not retained as COPECs do not pose a risk. What the SLERA cannot conclude is if there actually are risks to receptors in the HRSA from constituents that are retained as COPECs, or if these constituents are site related or come from sources outside of the HRSA.

While there are limitations on the ecological and environmental setting data/information that were used to develop the Problem Formulation and conceptual model, the associated uncertainties are minimal. The HRSA is part of the larger Hackensack Meadowlands system. The ecology and environmental setting of this system have been well-studied for many years, and it is believed that the available data on this system are adequate to characterize the ecology, likely list of receptors and potential exposure pathways for the HRSA. As such, it is felt that the screening-level Problem Formulation is accurate, and the resulting exposure conditions and assessment endpoints are reflective of the actual ecology of the system.

Similarly, it is felt that the current surface sediment dataset used to conduct the screen is valid and spatially appropriate, and its results depict an extent and magnitude of constituents similar to what is seen in the larger Newark Bay Estuary. It is not believed that a larger dataset would affect the results of this screen.

The most substantial data uncertainty lies in the fact that there are no bioaccumulation data available for food web organisms in the HRSA. The absence of these data limited the type of screening-level risk analyses that could be conducted in this SLERA. As such, the actual bioaccumulation/biomagnification of contaminants in the HRSA remain unknown. For this reason, the bioaccumulation assessment in this SLERA is limited to the IBC screen in Tables 6-4, 6-5, and 6-6. This represents a substantial limitation of this SLERA, as previously discussed.

The uncertainties surrounding the sediment screen are substantial, and relate primarily to the conservative assumptions that are required by agency guidance. These include the use of maximum concentrations of constituents and LELs to conduct the screen in order to be as conservative as possible in the results. In addition, the SQGs that are prescribed by the NJDEP for use in this screen are not inclusive of the full set of guidelines/benchmarks that are available from both government agencies and the scientific literature. Including additional and, in some instances, more up-to-date guidelines/benchmarks could have a substantial impact on the outcome of the screen, at least for select constituent groups. In addition, consideration of factors that may limit

bioavailability of constituents in sediments and limit potential toxic effects (e.g., organic carbon and AVS) when setting benchmarks is not permitted in the SLERA.

Finally, the conservative method used to summarize the sediment chemistry data also has an effect on the screen and adds to the compounded conservatism. This includes the assumption of toxic effects additivity for groups of organic compounds such as dioxins/furans, PCBs and PAHs that are summed together for analysis. More importantly, the use of one-half the SQL to represent concentrations of constituents that are not detected in a sample can substantially overstate the actual concentration. This is most readily apparent for the SVOC results in the HRSA dataset. In many instances, the one-half SQL for these compounds in several samples was substantially higher than the actual detected concentrations in other samples. As such, the mean and maximum concentrations of many of these compounds are artificially inflated in the dataset. Furthermore, for the sum of PAHs, this overstatement is compounded in the addition of many of the artificially inflated values, resulting if a gross overstatement of the total and L-/H- PAH categories.

The substantial uncertainties that exist affect the outcome of the SLERA. However, by limiting the basic conclusions of the SLERA to the fact that several constituents/ constituent groups (from unknown sources either inside and/or outside the HRSA) are present at levels that could potentially pose a risk to ecological receptors, and that these issues warrant further discussion/evaluation, the impact of the uncertainties is minimized.

6.4.4 Scientific Management Decision Point

As discussed in Section 6.1.2, the DQOs and decision rules to meet the objectives for the SLERA, as identified in the approved HRSA RIWP (BBL, 2005a), include:

DQO 1. Preliminarily characterize (through sediment sampling) the nature of contamination within key ecological habitats, primarily mudflats and near-shore areas

- Are the current habitat data and information for the HRSA sufficient to delineate and characterize habitat types and identify the primary organisms (i.e., ecological receptors) that use those habitats?

- Does potential chemical contamination exist in the identified habitats and, if so, to what extent?

DQO 2. Estimate risks to key ecological receptors

- Does the potential exist for contaminant-related risks to ecological receptors in one or more habitats of the HRSA based on a screening-level evaluation of the sediment data?

- If there are apparent risks identified by the SLERA, is a BERA warranted for the HRSA to further define and quantify risk?

The results of this SLERA indicate that sufficient data and information exist to demonstrate that constituents are present in sediments within habitats of the HRSA that are used by various ecological receptors (benthic and epibenthic invertebrates, fish, birds and mammals). Furthermore, at the existing concentrations, ecological risks cannot be ruled out for many of these constituents. These constituents have been identified as COPECs (Table 6-7). The sources of these COPECs is in question, as the HRSA is part of the larger Hackensack Meadowlands and NY/NJ Harbor Estuary system, which is a tidal estuarine system with a long history of pollution from a substantial number of sources.

In evaluating the results of the SLERA, it is clear that more consideration needs to be given to risk. The key data gap in this SLERA is the lack of bioaccumulation data for organisms in the food web of the HRSA. This limits the ability of this SLERA to screen for potential risks from bioaccumulation/biomagnification in the food web via the ingestion pathway. A more refined risk analysis is also warranted to evaluate the actual risks that might be posed by the COPECs identified in this SLERA.

In considering the need for conducting a BERA, the discussions between the PRG and regulatory agencies should focus on the big-picture issues related to overall risk in this system. While there may be ecological risks from contaminants present in the HRSA, the sources of the constituents that pose those risks, and the potential relevance and magnitude of and ability to manage those risks in the context of the overall risk from urban background in the larger Hackensack Meadowlands system need to be considered. If a BERA is to be conducted, it must be carefully planned to decipher actual incremental risks from constituents that emanate from PRG-related versus other sources. As such, the recommendation to conduct a BERA cannot be made at this time, pending these discussions.

7. Summary

As stated in the approved HRSA RIWP (BBL, 2005a), the HRSA RI Program was implemented to evaluate the nature and extent of constituents in sediments, and to conduct a SLERA. Under this program, sediment samples were collected in the fall of 2006 and analyzed for various chemical, radiochemical, and physical parameters. As demonstrated in this Report, the associated RI data allowed for the successful achievement of the two goals outlined above.

The findings presented were supported by a high level of data quality, obtained through the validation of 100 percent of the analytical results. In fact, the Quantitative Data Quality assessment ranged from 'Very Good' to 'Excellent' based on the ratio of valid analytical data to all analytical data obtained. Certain sample results required qualification for varying reasons, including high moisture content, dilution, or minor holding time exceedances. However, these qualifications had a negligible effect on the overall dataset, allowing for meaningful data interpretation and analysis.

As indicated above, the PRG was able to characterize constituent distributions throughout the HRSA, focusing primarily on regional COIs. However, numerous other analytes were measured at relatively high frequencies, and will become an important part of the on-going Source Identification component of the overall HRSA RI Program. Relative to the COIs considered in this report, the following general trends were observed:

- Sediments obtained from cores located in the southern HRSA and closer to shore contain higher concentrations than do those farther from shore and in the northern HRSA

- Higher mean concentrations are found in the upper 2 feet (many times in the top 6 inches) of sediment, with mean concentrations decreasing deeper into the sediment column

In addition, the lack of quantifiable radiochemistry data suggests that there is minimal long-term net deposition within the confines of the HRSA, a finding that is supported by higher constituent concentrations detected closer to the sediment surface. A notable exception was found at core 005, where higher concentrations were observed with depth. This suggests that while the HRSA as a whole is not highly depositional, isolated sediment-accumulating pockets may exist.

Using the same sediment characterization data obtained from the RI Program, the PRG also was able to conduct a SLERA, the findings of which are summarized below:

- Sufficient sediment data and ecological information exist to demonstrate that a substantial number of constituents are present at levels above conservative ecotoxicological screening benchmarks within habitats of the HRSA

- The constituents of potential ecological concern (COPECs), as identified in this conservative SLERA, may pose risks from both direct toxicity to sediment dwelling organisms (i.e., benthic invertebrates), as well as bioaccumulative risks from consuming contaminated prey and potential biomagnification of COPECs in the food web of the system

- These types and magnitudes of COPECs, as identified in this conservative SLERA, are similar to those found throughout the Newark Bay Estuary, including areas upstream and downstream of the HRSA

The need for further risk assessment work (e.g., the conduct of a BERA) should be weighed in terms of being able to decipher incremental risks from site (i.e., facility) – specific COPEC contributions, versus the widespread urban/industrial background contributions to the HRSA. Discussions between the PRG and NJDEP are recommended to identify the need and/or scope of such future risk/source identification activities.

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Table 2-1
Shoreline Types

Shoreline Composition/ Cover Type	Western Shoreline (feet)	Eastern Shoreline (feet)	Total – HRSA (feet)
Vegetated – *P. australis* marsh	490	3,113	3,603
Vegetated – *P. australis* marsh with *S. alterniflora* fringe	596	5,269	5,865
Vegetated - Other	204	2,077	2,281
Riprap	6,516	4,344	10,860
Bulkhead	6,612	3,279	9,891
Total Linear Footage	14,418	18,082	32,500

Table 2-2
Wildlife Observations

	OW	PM	SM	MF	OP	LF
Mammals						
Ondatra zibethica (Muskrat)		o	t			
Procyon lotor (Raccoon)		t	t			
Rattus norvegicus (Norway Rat)		t	t			
Birds						
Agelaius phoeniceus (Red-winged Blackbird)		r	r			r
Anas platyrhynchos (Mallard)	r	h	h	h		
Anas rubripes (American Black Duck)			h	h		
Anas strepera (Gadwall)	r					
Ardea herodias (Great Blue Heron)	f	h	h			
Branta canadensis (Canada Goose)	r	r	h	r		
Bucephala albeola (Bufflehead)	h					
Buteo jamaicensis (Red-tailed Hawk)		f	f			r
Buteo lineatus (Red-shouldered Hawk)						r
Charadrius vociferous (Killdeer)				h		
Circus cyaneus (Northern Harrier)		h				
Clangula hyemalis (Oldsquaw)	h					
Columba livia (Rock Dove)					r	
Corcus brachyrynochos (Common Crow)						r
Falco sparverius (American Kestrel)	f					
Fulica americana (American Coot)			h			
Gavia stellata (Red-throated Loon)	h					
Larus argentatus (Herring Gull)	r	r	r	r	r	r
Larus delawarensis (Ring-billed Gull)	r	r	r	r	r	
Larus marinus (Great Black-backed Gull)	r	f	r	r	r	r
Mergus merganser (Common Merganser)	h					
Nycticorax nycticorax (Black-crowned Night-Heron)		r	r			
Pandion haliaetus (Osprey)	f					
Phalacrocora auritus (Double-crested Cormorant) h		f	f	r	r	
Sturnus vulgaris (Starling)	f	r	f		r	
Turdus migratorius (Robin)						r

Notes:
1. o - observed
2. t - tracks
3. r - resting
4. f - flying
5. h - feeding

Table 2-2
Wildlife Observations

Habitat Classifications

OW=Open Water
Open water habitat is defined as the water area with in the confines of the River. The River serves as a major feeding area for a number of species and resting area for others.

PM=*Phragmites* -dominated Marsh
Phragmites australis marsh is the areas along the river that are dominate by common reed (*P. australis*). The dense growth of the phragmites marsh has been well documented in its decrease of wildlife use by a number of species.

SM=Salt Marsh
Salt marsh habitat is tidal marsh that is dominated by species salt marsh cordgrass (*Spartina alterniflora*), big cordgrass (*Spartina cynosuroides*), saltmeadow cordgrass (*Spartina patens*), and saltgrass (*Distichlis spicata*) with eastern false-willow (*Bacharis halimifolia*) and big-leaf sumpweed (*Iva frutescens*). The narrow tidal creeks though the marsh were included as a component of the habitat. Salt marsh is documented as the most productive habitat along the coast. Many times, *S. alterniflora* and *P. australis* dominated the same marsh in different areas, *S. alterniflora's* tolerance of tidal inundation frequently results in a *S. alterniflora* fringe along a marsh where the upper marsh is dominated by *P. australis*.

MF=Mudflats
Mudflat areas were exposed during the low tide event, and generally extended from the grass or bulkhead lower limit to the open water. A number of species were observed using mudflats as resting areas. The area will be heavily used as foraging habitat during the spring and fall migrations.

OP=Old Pilings and Structures in or along waters edge
The old pilings and deteriorating bulkheads serve as resting/perching areas for birds and also create submerged habitats for numerous species of fish. Bridges spanning the River were also included in this category, as the superstructure present similar features for perching birds and the abutments create structure below the waters surface.

LF=Landfills
Several landfills are located along the banks of the HRSA. Large trees growing atop the landfills, in conjunction with the raised elevation of the landfill itself, offer good vantage points for birds of prey. Several species of hawk were observed perched among the trees and circling above the landfill.

Table 3-1
Final Sample Location Coordinates

Location ID	Recovered Length (ft)	Northing (NAD83)	Easting (NAD83)
HRRISED001	3.25	698006	604673
HRRISED002	2.65	698465	604919
HRRISED003	3.0	695044	607294
HRRISED004	1.8	694546	607528
HRRISED005	12.7	695475	608181
HRRISED006	4.15	694903	608464
HRRISED007	3.1	695926	609026
HRRISED008	3.0	695504	609168
HRRISED009	2.2	696556	609711
HRRISED010	4.0	696473	609946
HRRISED011	3.7	697482	609700
HRRISED012	1.85	697517	609898
HRRISED013	4.0	697808	609185
HRRISED014	2.0	698207	609252
HRRISED015	2.65	698821	609371
HRRISED016	3.8	697658	608253
HRRISED017	4.36	698114	608259
HRRISED018	4.3	698471	608276
HRRISED019	12.0	698814	608285
HRRISED020	3.6	699108	608292
HRRISED021	2.85	697514	607461
HRRISED022	3.4	697949	607347
HRRISED023	4.3	698350	607263
HRRISED024	3.9	698644	607199
HRRISED025	3.5	698912	607134
HRRISED026	2.0	697878	606314
HRRISED027	4.05	698205	606296
HRRISED028	4.05	698652	606293
HRRISED029	3.15	697754	605190
HRRISED030	3.3	698285	605360
HRRISED031	1.5	698578	604284
HRRISED032	3.5	698774	604709
HRRISED034	4.15	699983	604623
HRRISED035	4.0	700731	604099
HRRISED036	10.9	700491	604719
HRRISED037	2.8	699100	604138
HRRISED038	1.95	699189	604544
HRRISED039	0.5	694945	606436
HRRISED040	0.5	694957	606614
HRRISED041	0.5	695008	606814
HRRISED042	0.5	694187	606687
HRRISED043	0.5	694213	606782
HRRISED044	0.5	694255	606890
HRRISED045	0.5	694809	608490
HRRISED046	0.5	694890	608553
HRRISED047	0.5	694940	608624
HRRISED048	0.5	695725	608365
HRRISED049	0.5	695832	608548
HRRISED050	0.5	695912	608706
HRRISED051	0.5	699225	608636
HRRISED052	0.5	699268	608545
HRRISED053	0.5	699258	608468
HRRISED054	0.5	699190	607725
HRRISED055	0.5	698978	606915
HRRISED056	0.5	698690	606123
HRRISED057	0.5	698516	605257

Notes:
1. NAD83 - North American Datum 1983

Table 4-1
Summary Statistics for Select VOCs

Sampling Area	Benzene (ug/kg)				Ethylbenzene (ug/kg)				Toluene (ug/kg)				Xylene (ug/kg)			
	Number of Samples	Number of Detects	Arithmetic Mean of Detects	Range of Detects	Number of Samples	Number of Detects	Arithmetic Mean of Detects	Range of Detects	Number of Samples	Number of Detects	Arithmetic Mean of Detects	Range of Detects	Number of Samples	Number of Detects	Arithmetic Mean of Detects	Range of Detects
IN-RIVER SAMPLES																
All Depths	105	13	287	3.3 – 1,800	105	13	1,630	3.8 – 8,600	105	20	102	0.89 – 1,400	105	14	1,680	13 – 12,000
0-0.5 ft	37	2	657	14 – 1,300	37	4	1,370	3.8 – 5,300	37	9	8.84	1.8 – 23	37	3	105	15 – 200
0.5-2 ft	36	4	528	3.3 – 1,800	36	4	1,620	110 – 5,800	36	6	239	0.89 – 1,400	36	4	3,120	32 – 12,000
2-4 ft	20	3	93.9	3.6 – 260	20	2	4,540	470 – 8,600	20	2	253	36 – 470	20	3	3,500	22 – 10,000
4-6 ft	3	1	5.3	NA	3	0	ND	ND	3	0	ND	ND	3	1	13	NA
6-8 ft	3	1	9.5	NA	3	1	42	NA	3	1	2.5	NA	3	1	42	NA
8-10 ft	3	1	12	NA	3	1	110	NA	3	1	16	NA	3	1	130	NA
10-12 ft	3	1	3.4	NA	3	1	27	NA	3	1	3.8	NA	3	1	41	NA
MUDFLAT SAMPLES																
All Mudflats	19	0	ND	ND	19	0	ND	ND	19	1	2.2	NA	19	0	ND	ND
Mudflat 1	3	0	ND	ND	3	0	ND	ND	3	1	2.2	NA	3	0	ND	ND
Mudflat 2	3	0	ND	ND	3	0	ND	ND	3	0	ND	ND	3	0	ND	ND
Mudflat 4	3	0	ND	ND	3	0	ND	ND	3	0	ND	ND	3	0	ND	ND
Mudflat 6	3	0	ND	ND	3	0	ND	ND	3	0	ND	ND	3	0	ND	ND
Mudflat 9	3	0	ND	ND	3	0	ND	ND	3	0	ND	ND	3	0	ND	ND
Mudflat 10	4	0	ND	ND	4	0	ND	ND	4	0	ND	ND	4	0	ND	ND

Notes:
1. VOCs - Volatile Organic Compounds
2. ug/kg - micrograms per kilogram
3. ND - Not Detected
4. NA - Not Applicable
5. ft - feet
6. Field and duplicate sample results were averaged together to create one result.

Table 4-2
Summary Statistics for Select SVOCs

Sampling Area	1,2-DCB (ug/kg)				1,3-DCB (ug/kg)				1,4-DCB (ug/kg)			
	Number of Samples	Number of Detects	Arithmetic Mean of Detects	Range of Detects	Number of Samples	Number of Detects	Arithmetic Mean of Detects	Range of Detects	Number of Samples	Number of Detects	Arithmetic Mean of Detects	Range of Detects
IN-RIVER SAMPLES												
All Depths	105	7	129	11 – 640	105	13	330	7.7 – 2,700	105	26	665	9.4 – 8,500
0-0.5 ft	37	6	143	11 – 640	37	9	405	7.7 – 2,700	37	16	939	14 – 8,500
0.5-2 ft	36	1	47	NA	36	4	160	8.3 – 530	36	8	259	9.4 – 1,400
2-4 ft	20	0	ND	ND	20	0	ND	ND	20	2	101	22 – 180
4-6 ft	3	0	ND	ND	3	0	ND	ND	3	0	ND	ND
6-8 ft	3	0	ND	ND	3	0	ND	ND	3	0	ND	ND
8-10 ft	3	0	ND	ND	3	0	ND	ND	3	0	ND	ND
10-12 ft	3	0	ND	ND	3	0	ND	ND	3	0	ND	ND
MUDFLAT SAMPLES												
All Mudflats	19	8	29.8	10 – 53	19	16	43.7	16 – 72	19	14	145	18 – 270
Mudflat 1	3	0	ND	ND	3	0	ND	ND	3	3	80	18 – 190
Mudflat 2	3	2	33.5	32 – 35	3	1	46	NA	3	3	187	180 – 190
Mudflat 4	3	2	21.5	10 – 33	3	3	28.3	16 – 45	3	3	128	65 – 210
Mudflat 6	3	2	17.5	16 – 19	3	0	ND	ND	3	2	98	86 – 110
Mudflat 9	3	1	53	NA	3	1	59	NA	3	1	210	NA
Mudflat 10	4	1	40	NA	4	1	72	NA	4	2	220	170 – 270

Table 4-2
Summary Statistics for Select SVOCs

Sampling Area	1,2,4-TCB (ug/kg)				Naphthalene (ug/kg)				Total PAHs (ug/kg)			
	Number of Samples	Number of Detects	Arithmetic Mean of Detects	Range of Detects	Number of Samples	Number of Detects	Arithmetic Mean of Detects	Range of Detects	Number of Samples	Number of Detects	Arithmetic Mean of Detects	Range of Detects
IN-RIVER SAMPLES												
All Depths	105	12	1,210	61 – 5,600	105	59	268,000	14 – 11,000,000	105	74	1,960,000	13 – 75,300,000
0-0.5 ft	37	10	1,350	61 – 5,600	37	31	110,000	29 – 3,200,000	37	37	1,680,000	98 – 56,800,000
0.5-2 ft	36	2	545	210 – 880	36	17	666,000	14 – 11,000,000	36	25	3,210,000	13 – 75,300,000
2-4 ft	20	0	ND	ND	20	7	45,600	26 – 250,000	20	10	506,000	190 – 3,790,000
4-6 ft	3	0	ND	ND	3	1	9,200	NA	3	1	308,000	NA
6-8 ft	3	0	ND	ND	3	1	200,000	NA	3	1	482,000	NA
8-10 ft	3	0	ND	ND	3	1	430,000	NA	3	1	708,000	NA
10-12 ft	3	0	ND	ND	3	1	89,000	NA	3	1	236,000	NA
MUDFLAT SAMPLES												
All Mudflats	19	8	71.8	23 – 120	19	14	458	39 – 1,200	19	19	22,200	239 – 47,600
Mudflat 1	3	0	ND	ND	3	1	92	NA	3	3	8,240	2,220 – 14,200
Mudflat 2	3	1	110	NA	3	2	1,040	880 – 1,200	3	3	34,500	24,600 – 42,100
Mudflat 4	3	3	52.3	23 – 98	3	3	550	150 – 780	3	3	32,700	15,100 – 46,700
Mudflat 6	3	2	53	48 – 58	3	3	358	170 – 615	3	3	24,000	15,600 – 39,700
Mudflat 9	3	1	120	NA	3	1	280	NA	3	3	6,450	239 – 18,100
Mudflat 10	4	1	81	NA	4	4	308	39 – 670	4	4	26,100	3,070 – 47,600

Notes:
1. SVOCs - Semi Volatile Organic Compounds
2. 1,2-DCB - 1,2-Dichlorobenzene
3. 1,3-DCB - 1,3-Dichlorobenzene
4. 1,4-DCB - 1,4-Dichlorobenzene
5. 1,2,4-TCB - 1,2,4-Trichlorobenzene
6. Total PAHs - Total Polycyclic Aromatic Hydrocarbons
7. ug/kg - micrograms per kilogram
8. ND - Not Detected
9. NA - Not Applicable
10. ft - feet
11. Field and duplicate sample results were averaged together to create one result.

Table 4-3
Summary Statistics for Select Inorganics

Sampling Area	Total Chromium (mg/kg)				Total Cyanide (mg/kg)				Hexavalent Chromium (mg/kg)			
	Number of Samples	Number of Detects	Arithmetic Mean of Detects	Range of Detects	Number of Samples	Number of Detects	Arithmetic Mean of Detects	Range of Detects	Number of Samples	Number of Detects	Arithmetic Mean of Detects	Range of Detects
IN-RIVER SAMPLES												
All Depths	105	105	94.5	5.5 – 1170	105	14	2.01	0.33 – 8.3	105	17	2.21	0.34 – 19.7
0-0.5 ft	37	37	80.1	6.5 – 480	37	6	1.89	0.33 – 8.3	37	19	2.38	0.36 – 19.7
0.5-2 ft	36	36	107	5.5 – 1170	36	7	2.15	0.49 – 8	36	10	2.76	0.38 – 13.2
2-4 ft	20	20	110	16.8 – 750	20	7	1.7	1.7 – 1.7	20	11	1.18	0.34 – 7.6
4-6 ft	3	3	98.8	20.7 – 254	3	0	ND	ND	3	1	12.9	NA
6-8 ft	3	3	95.9	20.8 – 245	3	0	ND	ND	3	3	0.53	0.53 – 0.53
8-10 ft	3	3	72.7	22.2 – 173	3	0	ND	ND	3	3	0.747	0.52 – 1.2
10-12 ft	3	3	42.7	22.7 – 80.7	3	0	ND	ND	3	2	1.26	0.41 – 2.1
MUDFLAT SAMPLES												
All Mudflats	19	19	98.7	23.5 – 196	19	4	3.03	0.64 – 7.1	19	6	3.6	0.79 – 8.1
Mudflat 1	3	3	68.3	54.2 – 92	3	1	7.1	NA	3	0	ND	ND
Mudflat 2	3	3	145	118 – 196	3	1	0.87	NA	3	0	ND	ND
Mudflat 4	3	3	88.3	40.9 – 112	3	0	ND	ND	3	3	7.15	6.2 – 8.1
Mudflat 6	3	3	134	117 – 149	3	2	2.07	0.64 – 3.5	3	2	2.83	0.86 – 4.8
Mudflat 9	3	3	64.7	23.5 – 131	3	0	ND	ND	3	1	0.79	NA
Mudflat 10	4	4	93.8	67.8 – 127	4	0	ND	ND	4	1	0.82	NA

Table 4-3
Summary Statistics for Select Inorganics

Sampling Area	Lead (mg/kg)				Mercury (mg/kg)			
	Number of Samples	Number of Detects	Arithmetic Mean of Detects	Range of Detects	Number of Samples	Number of Detects	Arithmetic Mean of Detects	Range of Detects
IN-RIVER SAMPLES								
All Depths	105	105	80.7	0.045 – 709	105	102	1.73	0.0000475 – 21.5
0-0.5 ft	37	37	99.9	0.045 – 709	37	37	1.59	0.0000475 – 11.8
0.5-2 ft	36	36	75.3	1.9 – 555	36	33	1.69	0.02 – 21.4
2-4 ft	20	10	62	7.5 – 370	20	20	2.01	0.019 – 21.5
4-6 ft	3	3	87.6	8.3 – 245	3	3	3.72	0.026 – 11.1
6-8 ft	3	3	80.3	8.3 – 223	3	3	2.25	0.025 – 6.7
8-10 ft	3	3	75.4	8.9 – 207	3	3	1.09	0.028 – 3.2
10-12 ft	3	3	30.7	10.5 – 70.9	3	3	0.314	0.034 – 0.87
MUDFLAT SAMPLES								
All Mudflats	19	19	140	12.8 – 373	19	19	1.83	0.056 – 3.4
Mudflat 1	3	3	319	223 – 373	3	3	1.08	0.21 – 2.4
Mudflat 2	3	3	164	135 – 193	3	3	2.53	2.3 – 2.8
Mudflat 4	3	3	132	84.6 – 163	3	3	2.44	0.91 – 3.4
Mudflat 6	3	3	98.7	29.1 – 140	3	3	2.05	1.15 – 2.6
Mudflat 9	3	3	52	12.8 – 114	3	3	1.32	0.056 – 2.8
Mudflat 10	4	4	92.2	59.5 – 119	4	4	1.64	0.34 – 2.6

Notes:
1. mg/kg - milligrams per kilogram
2. ND - Not Detected
3. NA - Not Applicable
4. ft - feet
5. Field and duplicate sample results were averaged together to create one result.

Table 4-4
Summary Statistics for Select Aroclor PCBs

Sampling Area	Total Aroclor PCBs (ug/kg)			
	Number of Samples	Number of Detects	Arithmetic Mean of Detects	Range of Detects
IN-RIVER SAMPLES				
All Depths	104	20	363	30 – 2,320
0-0.5 ft	37	12	420	31 – 2,320
0.5-2 ft	36	5	353	30 – 1,410
2-4 ft	19	3	151	53 – 320
4-6 ft	3	0	ND	ND
6-8 ft	3	0	ND	ND
8-10 ft	3	0	ND	ND
10-12 ft	3	0	ND	ND
MUDFLAT SAMPLES				
All Mudflats	19	14	1,700	114 – 8,000
Mudflat 1	3	3	2,730	200 – 7,500
Mudflat 2	3	3	3,850	1,340 – 8,000
Mudflat 4	3	3	558	114 – 890
Mudflat 6	3	2	565	340 – 790
Mudflat 9	3	1	300	NA
Mudflat 10	4	2	475	470 – 480

Notes:
1. PCBs - Polychlorinated Biphenyls
2. ug/kg - micrograms per kilogram
3. ND - Not Detected
4. NA - Not Applicable
5. ft - feet
6. Field and duplicate sample results were averaged together to create one result.

Table 4-5
Summary Statistics for Select Congener PCBs

Sampling Area	Total Congener PCBs (pg/g)			
	Number of Samples	Number of Detects	Arithmetic Mean of Detects	Range of Detects
IN-RIVER SAMPLES				
All Depths	105	105	139,000	8.94 – 2,610,000
0-0.5 ft	37	37	237,000	865 – 2,270,000
0.5-2 ft	36	36	106,000	14.6 – 2,610,000
2-4 ft	20	20	77,000	8.94 – 774,000
4-6 ft	3	3	85,700	13.9 – 257,000
6-8 ft	3	3	53,700	13.8 – 161,000
8-10 ft	3	3	23,800	12.9 – 71,300
10-12 ft	3	3	397	13.4 – 1,160
MUDFLAT SAMPLES				
All Mudflats	19	19	3,170,000	794 – 27,500,000
Mudflat 1	3	3	6,010,000	494,000 – 15,500,000
Mudflat 2	3	3	11,400,000	1,930,000 – 27,500,000
Mudflat 4	3	3	993,000	236,000 – 1,830,000
Mudflat 6	3	3	522,000	481,500 – 566,000
Mudflat 9	3	3	102,000	794 – 264,000
Mudflat 10	4	4	842,000	11,200 – 2,760,000

Notes:
1. PCBs - Polychloroinated Biphenyls
2. pg/g - picograms per gram
3. ND - Not Detected
4. ft - feet
5. Field and duplicate sample results were averaged together to create one result.

Table 4-5
Summary Statistics for Select Congener PCBs

Sampling Area	Total Congener PCBs (pg/g)			
	Number of Samples	Number of Detects	Arithmetic Mean of Detects	Range of Detects
IN-RIVER SAMPLES				
All Depths	105	105	139,000	8.94 – 2,610,000
0-0.5 ft	37	37	237,000	865 – 2,270,000
0.5-2 ft	36	36	106,000	14.6 – 2,610,000
2-4 ft	20	20	77,000	8.94 – 774,000
4-6 ft	3	3	85,700	13.9 – 257,000
6-8 ft	3	3	53,700	13.8 – 161,000
8-10 ft	3	3	23,800	12.9 – 71,300
10-12 ft	3	3	397	13.4 – 1,160
MUDFLAT SAMPLES				
All Mudflats	19	19	3,170,000	794 – 27,500,000
Mudflat 1	3	3	6,010,000	494,000 – 15,500,000
Mudflat 2	3	3	11,400,000	1,930,000 – 27,500,000
Mudflat 4	3	3	993,000	236,000 – 1,830,000
Mudflat 6	3	3	522,000	481,500 – 566,000
Mudflat 9	3	3	102,000	794 – 264,000
Mudflat 10	4	4	842,000	11,200 – 2,760,000

Notes:
1. PCBs - Polychloroinated Biphenyls
2. pg/g - picograms per gram
3. ND - Not Detected
4. ft - feet
5. Field and duplicate sample results were averaged together to create one result.

Table 4-6
Summary Statistics for Select Pesticides

Sampling Area	4,4-DDD (ug/kg)				4,4-DDE (ug/kg)				4,4-DDT (ug/kg)				Total DDT (ug/kg)			
	Number of Samples	Number of Detects	Arithmetic Mean of Detects	Range of Detects	Number of Samples	Number of Detects	Arithmetic Mean of Detects	Range of Detects	Number of Samples	Number of Detects	Arithmetic Mean of Detects	Range of Detects	Number of Samples	Number of Detects	Arithmetic Mean of Detects	Range of Detects
IN-RIVER SAMPLES																
All Depths	105	60	119	0.55 – 4,200	104	40	55.5	0.36 – 650	103	14	121	0.63 – 1,400	105	69	160	0.57 – 5,600
0-0.5 ft	37	28	62.6	0.55 – 750	37	23	59.2	0.36 – 650	37	6	27.6	0.63 – 100	37	32	103	0.57 – 1,400
0.5-2 ft	36	17	284	0.83 – 4,200	36	9	65.9	0.82 – 470	36	6	249	3.5 – 1,400	36	21	329	0.82 – 5,600
2-4 ft	20	9	52.5	1.7 – 190	20	5	49.6	1 – 220	20	2	19.3	3.5 – 35	20	10	75.9	1 – 370
4-6 ft	3	2	16.2	1.4 – 31	2	0	ND	ND	2	0	ND	ND	3	2	16.2	1.4 – 31
6-8 ft	3	2	8.41	0.82 – 16	3	1	10	NA	2	0	ND	ND	3	2	13.4	0.82 – 26
8-10 ft	3	1	20	NA	3	1	5.5	NA	3	0	ND	ND	3	1	25.5	NA
10-12 ft	3	1	5.7	NA	3	1	1.2	NA	3	0	ND	ND	3	1	6.9	NA
MUDFLAT SAMPLES																
All Mudflats	19	18	31.8	0.92 – 150	19	18	25.4	0.68 – 68	19	9	13.4	1.8 – 48	19	19	60.5	1.6 – 218
Mudflat 1	3	3	81.7	18 – 150	3	3	29.2	9.5 – 68	3	2	6.35	5.1 – 7.6	3	3	115	35.6 – 218
Mudflat 2	3	3	23	22 – 24	3	3	36.3	27 – 42	3	1	4.9	NA	3	3	61	55.9 – 65
Mudflat 4	3	3	21.7	6.2 – 34	3	3	25	11 – 38	3	2	15.7	5.4 – 26	3	3	57.2	22.6 – 77
Mudflat 6	3	3	34.3	17 – 59	3	3	33.5	29.5 – 40	3	3	32.5	17 – 48	3	3	89.5	63.5 – 138
Mudflat 9	3	2	21.8	2.5 – 41	3	2	15.3	1.5 – 29	3	1	1.8	NA	3	3	25.3	1.8 – 70
Mudflat 10	4	4	11.7	0.92 – 23	4	4	13.7	0.68 – 27	4	1	4.8	NA	4	4	26.5	1.6 – 50

Notes:
1. 4,4-DDD - 4,4-Dichlorodiphenyldichloroethane
2. 4,4-DDE - 4,4-Dichlorodiphenyldichloroethylene
3. 4,4-DDT - Dichlorodiphenyltrichloroethane
4. Total DDT - Total Dichlorodiphenyltrichloroethane
5. ug/kg - micrograms per kilogram
6. ND - Not Detected
7. NA - Not Applicable
8. ft - feet
9. Field and duplicate sample results were averaged together to create one result.

Table 4-7
Summary Statistics for Select Dioxins/Furans

Sampling Area	2,3,7,8-TCDD (pg/g) Number of Samples	Number of Detects	Arithmetic Mean of Detects	Range of Detects
IN-RIVER SAMPLES				
All Depths	105	72	83.8	0.113 – 2,990
0-0.5 ft	37	36	121	0.181 – 2,990
0.5-2 ft	36	23	66.7	0.113 – 1,370
2-4 ft	20	9	13.5	0.153 – 86.6
4-6 ft	3	1	3.19	NA
6-8 ft	3	1	1.54	NA
8-10 ft	3	1	0.621	NA
10-12 ft	3	1	0.327	NA
MUDFLAT SAMPLES				
All Mudflats	19	19	79.7	0.241 – 310
Mudflat 1	3	3	30.7	4.1 – 72.1
Mudflat 2	3	3	134	94 – 183
Mudflat 4	3	3	148	23.6 – 310
Mudflat 6	3	3	101	92.2 – 106
Mudflat 9	3	2	21.6	0.241 – 55.3
Mudflat 10	4	4	52.4	1.32 – 114

Notes:
1. pg/g - picrograms per gram
2. TCDD - Tetrachlorodibenzo-p-dioxin
3. ND - Not Detected
4. NA - Not Applicable
5. ft - feet
6. Field and duplicate sample results were averaged together to create one result.

Table 4-8
Summary Statistics for Miscellaneous Parameters

Sampling Area	TEPH (mg/kg)				TOC (mg/kg)				ORP (mV)				pH			
	Number of Samples	Number of Detects	Arithmetic Mean of Detects	Range of Detects	Number of Samples	Number of Detects	Arithmetic Mean of Detects	Range of Detects	Number of Samples	Number of Detects	Arithmetic Mean of Detects	Range of Detects	Number of Samples	Number of Detects	Arithmetic Mean of Detects	Range of Detects
IN-RIVER SAMPLES																
All Depths	105	105	4,410	6.9 – 190,000	105	99	28,900	1,085 – 540,000	105	105	236	63.6 – 447	105	105	7.7	4.63 – 8.88
0-0.5 ft	37	37	5,940	7.8 – 180,000	37	33	27,200	1,085 – 220,000	37	37	262	91 – 447	37	32	7.77	6.62 – 8.48
0.5-2 ft	36	36	6,320	6.9 – 190,000	36	34	35,400	1,300 – 540,000	36	36	241	88.4 – 417	26	26	7.73	4.63 – 8.88
2-4 ft	20	20	709	7.4 – 10,000	20	20	23,100	1,400 – 54,000	20	20	205	63.6 – 326	20	20	7.62	7.18 – 8.3
4-6 ft	3	3	278	12 – 770	3	3	20,700	16,000 – 27,000	3	3	159	91.1 – 222	3	3	7.58	7.37 – 7.95
6-8 ft	3	3	561	28 – 1,600	3	3	25,000	20,000 – 34,000	3	3	161	115 – 192	3	3	7.59	7.3 – 8.08
8-10 ft	3	3	754	21 – 2,200	3	3	29,700	24,000 – 39,000	3	3	207	185 – 218	3	3	7.49	7.34 – 7.77
10-12 ft	3	3	24,300	17,000 –	3	3	292	39 – 790	3	3	230	212 – 246	3	3	7.41	7.21 – 7.76
MUDFLAT SAMPLES																
All Mudflats	19	19	938	30 – 3,400	19	19	48,800	8,800 – 170,000	19	19	161	63.8 – 323	19	19	7.83	7.22 – 8.39
Mudflat 1	3	3	1,340	130 – 3,400	3	3	38,900	8,800 – 66,000	3	3	240	168 – 323	3	3	7.78	7.48 – 8.28
Mudflat 2	3	3	1,560	390 – 3,300	3	3	40,000	37,000 – 44,000	3	3	137	87 – 222	3	3	7.83	7.64 – 8.04
Mudflat 4	3	3	1,290	370 – 2,800	3	3	35,700	32,000 – 41,000	3	3	98.5	86.8 – 115	3	3	8.1	7.8 – 8.39
Mudflat 6	3	3	1,090	655 – 1,300	3	3	39,800	34,500 – 48,000	3	3	85.5	63.8 – 105.8	3	3	7.85	7.77 – 8.01
Mudflat 9	3	3	323	170 – 630	3	3	106,000	48,000 –	3	3	206	120 – 249	3	3	7.38	7.22 – 7.57
Mudflat 10	4	4	253	30 – 740	4	4	36,500	25,000 – 52,000	4	4	191	100 – 275	4	4	7.98	7.86 – 8.09

Notes:
1. mg/kg - milligrams per kilogram
2. mV - millivolts
3. TOC - Total Organic Carbon
4. ORP - Oxidation Reduction Potential
5. TEPH - Total Extractable Petroleum Hydrocarbon
6. potential of Hydrogen
7. ND - Not Detected
8. NA - Not Applicable
9. ft - feet
10. Field and duplicate sample results were averaged together to create one result.

Table 4-9
AVS/SEM Analysis

Location ID	Depth (feet)	Date Collected	SEM_T/AVS
HRRISED001	0 - 0.5	11/3/2006	**1.6**
HRRISED002	0 - 0.5	10/26/2006	**3.1**
HRRISED003	0 - 0.5	10/25/2006	0.18
HRRISED004	0 - 0.5	10/25/2006	**2.0**
HRRISED005	0 - 0.5	11/1/2006	0.16
HRRISED006	0 - 0.5	11/1/2006	0.10
HRRISED007	0 - 0.5	11/7/2006	0.39
HRRISED008	0 - 0.5	11/1/2006	**7.0**
HRRISED009	0 - 0.5	11/7/2006	0.08
HRRISED010	0 - 0.5	11/3/2006	0.49
HRRISED011	0 - 0.5	11/2/2006	**3.8**
HRRISED012	0 - 0.5	11/3/2006	0.47
HRRISED013	0 - 0.5	10/24/2006	**2.0**
HRRISED014	0 - 0.5	10/27/2006	0.31
HRRISED015	0 - 0.5	10/31/2006	0.13
HRRISED016	0 - 0.5	11/2/2006	**2.2**
HRRISED017	0 - 0.5	10/31/2006	0.54
HRRISED018	0 - 0.5	10/31/2006	**3.1**
HRRISED019	0 - 0.5	11/1/2006	0.03
HRRISED020	0 - 0.5	10/27/2006	0.12
HRRISED021	0 - 0.5	10/24/2006	0.90
HRRISED022	0 - 0.5	10/24/2006	**2.4**
HRRISED023	0 - 0.5	10/27/2006	**1.2**
HRRISED024	0 - 0.5	10/27/2006	0.24
HRRISED025	0 - 0.5	10/27/2006	0.73
HRRISED026	0 - 0.5	10/25/2006	**2.3**
HRRISED027	0 - 0.5	10/31/2006	**2.2**
HRRISED028	0 - 0.5	11/2/2006	0.19
HRRISED029	0 - 0.5	11/3/2006	0.70
HRRISED030	0 - 0.5	10/26/2006	**4.0**
HRRISED031	0 - 0.5	10/25/2006	**2.0**
HRRISED032	0 - 0.5	10/26/2006	0.33
HRRISED034	0 - 0.5	10/31/2006	**1.6**
HRRISED035	0 - 0.5	10/31/2006	0.55
HRRISED036	0 - 0.5	11/2/2006	0.29
HRRISED037	0 - 0.5	10/24/2006	**2.2**
HRRISED038	0 - 0.5	10/24/2006	**1.3**
HRRISED039	0 - 0.5	10/24/2006	**5.6**
HRRISED040	0 - 0.5	10/26/2006	0.13
HRRISED041	0 - 0.5	10/26/2006	0.52
HRRISED042	0 - 0.5	10/24/2006	**26**
HRRISED043	0 - 0.5	10/25/2006	**8.7**
HRRISED044	0 - 0.5	10/25/2006	**7.4**
HRRISED045	0 - 0.5	10/25/2006	**7.6**
HRRISED046	0 - 0.5	10/25/2006	0.96

Table 4-9
AVS/SEM Analysis

Location ID	Depth (feet)	Date Collected	SEM_T/AVS
HRRISED047	0 - 0.5	10/25/2006	0.44
HRRISED048	0 - 0.5	11/1/2006	0.03
HRRISED049	0 - 0.5	10/31/2006	0.23
HRRISED050	0 - 0.5	11/1/2006	0.36
HRRISED051	0 - 0.5	10/26/2006	**1.2**
HRRISED052	0 - 0.5	10/31/2006	0.19
HRRISED053	0 - 0.5	10/26/2006	0.93
HRRISED054	0 - 0.5	10/26/2006	**5.0**
HRRISED055	0 - 0.5	10/31/2006	0.64
HRRISED056	0 - 0.5	10/31/2006	0.14
HRRISED057	0 - 0.5	10/31/2006	0.58

Notes:

1. SEM = simultaneously extracted metals
2. AVS = acid volatile sulfide
3. SEMT is calculated according to the USEPA (2002) as the molar sum of the concentrations of cadmium (Cd), copper (Cu), lead (Pb), mercury (Hg), nickel (Ni), silver (Ag), and zinc (Zn), extracted simultaneously with AVS. Half the concentration of Ag is used to account for the fact that it is monovalent.

Table 4-10
Summary of Grain Size Data

Sample ID	(feet)	Clay % Weight Retained	Silt % Weight Retained	Sand % Weight Retained	Gravel % Weight Retained
IN-RIVER SAMPLES					
HRRISED001C-01	0 - 0.5	0.5	12.25	87.2	0.05
HRRISED001C-02	0.5 - 2	0.5	4.5	94.9	0.1
HRRISED002A-01	0 - 0.5	0.5	0.5	98.95	0.05
HRRISED002A-02	0.5 - 2	2	10	87.9	0.1
HRRISED003C-01	0 - 0.5	4	25	70.8	0.2
HRRISED003C-02	0.5 - 2	16.5	33.5	49.85	0.15
HRRISED003C-03	2 - 4	33	64	2.7	0.3
HRRISED004B-01	0 - 0.5	9.5	76.5	13.7	0.3
HRRISED004B-02	0.5 - 2	7.5	67.5	17.8	7.2
HRRISED005B-01	0 - 0.5	3	61	35.6	0.4
HRRISED005B-02	0.5 - 2	2	68	29.4	0.6
HRRISED005B-03	2 - 4	3	59.5	36.9	0.6
HRRISED005B-04	4 - 6	2	83	14.9	0.1
HRRISED005B-05	6 - 8	6	70	23.3	0.7
HRRISED005B-06	8 - 10	8	84	7.3	0.7
HRRISED005B-07	10 - 12	11	53	35.8	0.2
HRRISED006B-01	0 - 0.5	4	78.5	17	0.5
HRRISED006B-02	0.5 - 2	0.5	74.5	24.6	0.4
HRRISED006B-03	2 - 4	4	88	7.7	0.3
HRRISED007E-01	0 - 0.5	1.25	21.25	77.3	0.2
HRRISED007E-02	0.5 - 2	4.5	66.5	28.6	0.4
HRRISED008B-01	0 - 0.5	1	14	84.6	0.4
HRRISED008B-02	0.5 - 2	1	11	87.9	0.1
HRRISED009C-01	0 - 0.5	0.5	31.5	67.8	0.2
HRRISED010B-01	0 - 0.5	7	28	64.5	0.5
HRRISED010B-02	0.5 - 2	11	71	16.9	1.1
HRRISED010B-03	2 - 4	16	76	7.6	0.4
HRRISED011A-01	0 - 0.5	2	1.25	96.75	0
HRRISED011A-02	0.5 - 2	2	1.5	96.5	0
HRRISED011A-03	2 - 4	2	7	90.9	0.1
HRRISED013B-01	0 - 0.5	2	3	94.9	0.1
HRRISED013B-02	0.5 - 2	1	13	85.9	0.1
HRRISED013B-03	2 - 4	7	54	38.6	0.4
HRRISED014A-01	0 - 0.5	6	58	35.5	0.5
HRRISED014A-02	0.5 - 2	10	61	28.8	0.2
HRRISED015A-01	0 - 0.5	2	70	27.7	0.3
HRRISED015A-02	0.5 - 2	12	81	6.8	0.2
HRRISED016B-01	0 - 0.5	13	78	8.6	0.4
HRRISED016B-02	0.5 - 2	12	81.5	6	0.5
HRRISED016B-03	2 - 4	15	78	6.6	0.4
HRRISED017B-01	0 - 0.5	1.25	18.5	80.05	0.2
HRRISED017B-02	0.5 - 2	11	62	26.6	0.4
HRRISED017B-03	2 - 4	13	69	17.7	0.3
HRRISED018B-01	0 - 0.5	1	17.5	75	6.5
HRRISED018B-02	0.5 - 2	4	34	61.5	0.5
HRRISED018B-03	2 - 4	6	51	42.7	0.3
HRRISED019B-01	0 - 0.5	10.5	65.5	23.5	0.5
HRRISED019B-02	0.5 - 2	13	66	20.5	0.5
HRRISED019B-03	2 - 4	13	68	18.6	0.4
HRRISED019B-04	4 - 6	12	72	15.5	0.5
HRRISED019B-05	6 - 8	11.5	71.5	16.6	0.4
HRRISED019B-06	8 - 10	3	79	17.5	0.5
HRRISED019B-07	10 - 12	12	73	14.7	0.3

Table 4-10
Summary of Grain Size Data

Sample ID	(feet)	Clay % Weight Retained	Silt % Weight Retained	Sand % Weight Retained	Gravel % Weight Retained
HRRISED020A-01	0 - 0.5	8	85	6.7	0.3
HRRISED020A-02	0.5 - 2	12	80.5	7.1	0.4
HRRISED020A-03	2 - 4	13	79	7.7	0.3
HRRISED021B-01	0 - 0.5	3	23	73.6	0.4
HRRISED021B-02	0.5 - 2	8.5	34.5	56.85	0.15
HRRISED022A-01	0 - 0.5	18	77	4.4	0.6
HRRISED022A-02	0.5 - 2	17	78	4.5	0.5
HRRISED023A-01	0 - 0.5	3	33	63.8	0.2
HRRISED023A-02	0.5 - 2	12	61	26.7	0.3
HRRISED023A-03	2 - 4	12	47.5	40.2	0.3
HRRISED024A-01	0 - 0.5	0.5	76.5	22.7	0.3
HRRISED024A-02	0.5 - 2	13	65	21.7	0.3
HRRISED024A-03	2 - 4	2	79	18.8	0.2
HRRISED025B-01	0 - 0.5	5	66	28.4	0.6
HRRISED025B-02	0.5 - 2	6.5	80.5	12.7	0.3
HRRISED025B-03	2 - 4	8	82	9.7	0.3
HRRISED026C-01	0 - 0.5	33	56	10.5	0.5
HRRISED026C-02	0.5 - 2	31.5	64.5	3.6	0.4
HRRISED027B-01	0 - 0.5	0.5	3	96.4	0.1
HRRISED027B-02	0.5 - 2	0.5	31.5	67.8	0.2
HRRISED027B-03	2 - 4	8	75.5	16.2	0.3
HRRISED028A-01	0 - 0.5	7	58	34.2	0.8
HRRISED028A-02	0.5 - 2	8	72	19.6	0.4
HRRISED028A-03	2 - 4	9.5	75.5	14.6	0.4
HRRISED029D-01	0 - 0.5	0.5	1	98.5	0
HRRISED029D-02	0.5 - 2	0.5	2	97.5	0
HRRISED030B-01	0 - 0.5	0.5	2	97.5	0
HRRISED030B-02	0.5 - 2	0.5	3	96.5	0
HRRISED030B-03	2 - 4	0.5	12	87.5	0
HRRISED031A-01	0 - 0.5	37	60	2.6	0.4
HRRISED031A-02	0.5 - 2	32	65	2.6	0.4
HRRISED032A-01	0 - 0.5	0.5	26.5	72.8	0.2
HRRISED032A-02	0.5 - 2	10	69	20.9	0.1
HRRISED032A-03	2 - 4	7	73	19.5	0.5
HRRISED034B-01	0 - 0.5	5	77.5	17.4	0.1
HRRISED034B-02	0.5 - 2	8.5	83.5	7.7	0.3
HRRISED034B-03	2 - 4	11	77	11.9	0.1
HRRISED035B-01	0 - 0.5	0.5	9	90.4	0.1
HRRISED035B-02	0.5 - 2	1	20	78.7	0.3
HRRISED036B-01	0 - 0.5	9	80	10.6	0.4
HRRISED036B-02	0.5 - 2	10.5	82.5	6.4	0.6
HRRISED036B-03	2 - 4	11.5	78.5	9.5	0.5
HRRISED036B-04	4 - 6	10.5	79.5	9.5	0.5
HRRISED036B-05	6 - 8	11.5	78.5	9.6	0.4
HRRISED036B-06	8 - 10	11	77.5	11.1	0.4
HRRISED036B-07	10 - 12	10.5	69.5	19.7	0.3
HRRISED037A-01	0 - 0.5	31	53	15.5	0.5
HRRISED037A-02	0.5 - 2	32	64	3.6	0.4
HRRISED038A-01	0 - 0.5	1	14	84.8	0.2
HRRISED038A-02	0.5 - 2	6	17	76.8	0.2

Table 4-10
Summary of Grain Size Data

Sample ID	(feet)	Clay % Weight Retained	Silt % Weight Retained	Sand % Weight Retained	Gravel % Weight Retained
MUDFLAT SAMPLES					
HRRISED039A-01	0 - 0.5	8	69	20.5	2.5
HRRISED040A-01	0 - 0.5	4	74	21.8	0.2
HRRISED041A-01	0 - 0.5	3.5	61.5	34.6	0.4
HRRISED042A-01	0 - 0.5	0.5	7.5	91.8	0.2
HRRISED043A-01	0 - 0.5	0.5	30.5	68.6	0.4
HRRISED044A-01	0 - 0.5	3.5	54.5	41.5	0.5
HRRISED045A-01	0 - 0.5	0.5	34.5	64.8	0.2
HRRISED046A-01	0 - 0.5	4	54	41.6	0.4
HRRISED047A-01	0 - 0.5	1	38	60.6	0.4
HRRISED048A-01	0 - 0.5	6.5	83.5	8.8	1.2
HRRISED049A-01	0 - 0.5	5	76	18.6	0.4
HRRISED050A-01	0 - 0.5	7	79	13.6	0.4
HRRISED051A-01	0 - 0.5	0.5	0	98.9	0.6
HRRISED052A-01	0 - 0.5	13	65.5	21.2	0.3
HRRISED053A-01	0 - 0.5	7	58	34.4	0.6
HRRISED054A-01	0 - 0.5	17	78	4.6	0.4
HRRISED055A-01	0 - 0.5	6	70	22.9	1.1
HRRISED056A-01	0 - 0.5	5	68	26.7	0.3
HRRISED057A-01	0 - 0.5	10	76	13.7	0.3

Notes:

1. Based on the available size data for each sample, data were transformed into “percent retained by weight” by solving for the differences between the above size classifications as follows:
   Gravel = 100 – (Percent passing at 3.35 mm)
   Sand = (Percent passing at 3.35 mm) – (Percent passing at 0.064 mm)
   Silt = (Percent passing at 0.064 mm) – (Percent passing at 0.001 mm)
   Clay = Percent passing at 0.001 mm

Table 4-11
Summary Statistics for Select Grain Size Fractions

Sampling Interval	Clay % Weight Retained		Silt % Weight Retained		Sand % Weight Retained		Gravel % Weight Retained	
	Arithmetic Mean	Range	Arithmetic Mean	Range	Arithmetic Mean	Range	Arithmetic Mean	Range
IN-RIVER SAMPLES								
All Depths	8.3	0.5 - 37	52.7	0.5 – 88	38.6	2.6 – 99	0.5	0 – 7.2
0-0.5 ft	5.4	0.5 – 33	44.5	0.5 – 88	49.6	2.7 – 99	0.5	0 – 7.2
0.5-2 ft	10.6	0.5 – 33	63.8	17.5 - 85	25.1	3.6 – 80.1	0.6	0.2 – 6.5
2-4 ft	8	0.5 – 37	47.4	1 – 83.5	44.4	2.6 – 99	0.3	0 – 0.8
4-6 ft	11.2	10.5 – 11.5	78.8	78.5 – 79.5	9.5	9.5 – 9.6	0.5	0.4 – 0.5
6-8 ft	17.5	10.5 – 31	66.7	53 – 77.5	15.4	11.1 – 19.7	0.4	0.3 – 0.5
8-10 ft	13	1 – 32	31.7	14 – 64	55.1	3.6 – 84.8	0.3	0.2 – 0.4
10-12 ft	3	0.5 – 8	36.7	3 – 75.5	60.1	16.2 – 96.4	0.2	0.1 – 0.3
MUDFLAT SAMPLES								
All Mudflats	5.4	0.5 – 17	56.7	0 – 83.5	37.3	4.6 – 98.9	0.6	0.2 – 2.5
Mudflat 1	1.5	0.5 – 3.5	30.8	7.5 – 54.5	67.3	41.5 – 91.8	0.4	0.2 – 0.5
Mudflat 2	5.2	3.5 – 8	68.2	61.5 – 74	25.6	20.5 – 34.6	1	0.2 – 2.5
Mudflat 4	1.8	0.5 – 4	42.2	34.5 – 54	55.7	41.6 – 64.8	0.3	0.2 – 0.4
Mudflat 6	6.2	5 – 7	79.5	76 – 83.5	13.7	8.8 – 18.6	0.7	0.4 – 1.2
Mudflat 9	6.8	0.5 – 13	41.2	0 – 65.5	51.5	21.2 – 98.9	0.5	0.3 – 0.6
Mudflat 10	9.5	5 – 17	73	68 – 78	17	4.6 – 26.7	0.5	0.3 – 1.1

Notes:
1. ft - feet
2. Field and duplicate sample results were averaged together to create one result.
3. The values on this table represent the percent weight retained. For example, 8.3% weight retained for clay indicates that 8.3% of the material was classified as clay.

Table 4-12
Summary of Analytical Completeness and Data Quality

Analyte	Number of Results Qualified[1]														Total Number of Results[3]	% Analytical Completeness[4]	% Unusable Data[5]	Qualitative Data Quality
	Unqualified Positive Results	U	U[2]	NJ	G	J/JG	JL/ JLG	JH/ JHG	EMPC	UJ	UL	R	M	UM				
VOCs																		
1,1,1-Trichloroethane		93								1	10			20	124	100%	0%	Excellent
1,1,2,2-Tetrachloroethane		74								13	20			17	124	100%	0%	Excellent
1,1,2-Trichloroethane		82								13	10			19	124	100%	0%	Excellent
1,1-Dichloroethane		93								1	10			20	124	100%	0%	Excellent
1,1-Dichloroethene		93								1	10			20	124	100%	0%	Excellent
1,2-Dichloroethane		85								1	20			18	124	100%	0%	Excellent
1,2-Dichloroethene (total)		93								1	10			20	124	100%	0%	Excellent
1,2-Dichloropropane		93								1	10			20	124	100%	0%	Excellent
2-Butanone	11	30			5	28	2			24	12		4	8	124	100%	0%	Excellent
2-Hexanone		66								26	15			17	124	100%	0%	Excellent
4-Methyl-2-pentanone		62								28	19			15	124	100%	0%	Excellent
Acetone		11			7	55	1			38	5			7	124	100%	0%	Excellent
Benzene	3	83			8					1	10		2	17	124	100%	0%	Excellent
Bromodichloromethane		93								1	10			20	124	100%	0%	Excellent
Bromoform		85								1	20			18	124	100%	0%	Excellent
Bromomethane		72								32	6			14	124	100%	0%	Excellent
Carbon Disulfide		67			16	1				12	10			18	124	100%	0%	Excellent
Carbon Tetrachloride		93								1	10			20	124	100%	0%	Excellent
Chlorobenzene		92			1		3			1	7			20	124	100%	0%	Excellent
Chloroethane		54								48	13			9	124	100%	0%	Excellent
Chloroform		93			2					1	10			18	124	100%	0%	Excellent
Chloromethane		58								57	1			8	124	100%	0%	Excellent
cis-1,3-Dichloropropene		93								1	10			20	124	100%	0%	Excellent
Dibromochloromethane		93								1	10			20	124	100%	0%	Excellent
Ethylbenzene	9	83			1			1		2	10		2	16	124	100%	0%	Excellent
Methylene Chloride		25	85							1	6			7	124	100%	0%	Excellent
Styrene		93								1	10			20	124	100%	0%	Excellent
Tetrachloroethene		93								1	10			20	124	100%	0%	Excellent
Toluene	7	78			11		2			1	8		1	16	124	100%	0%	Excellent
trans-1,3-Dichloropropene		82								13	10			19	124	100%	0%	Excellent
Trichloroethene		93								1	10			20	124	100%	0%	Excellent
Vinyl Chloride		93								1	10			20	124	100%	0%	Excellent
Xylenes (total)	8	81			3			1		2	10		2	17	124	100%	0%	Excellent
SVOCs																		
1,2,4-Trichlorobenzene	2	73			18						19			12	124	100%	0%	Excellent
1,2-Dichlorobenzene	1	63			12		2				36			10	124	100%	0%	Excellent
1,3-Dichlorobenzene	1	58			17		1				37			10	124	100%	0%	Excellent
1,4-Dichlorobenzene	1	43			35		4				34			7	124	100%	0%	Excellent
2,2'-oxybis(1-Chloropropane)		47									67			10	124	100%	0%	Excellent
2,4,5-Trichlorophenol		70									41			13	124	100%	0%	Excellent
2,4,6-Trichlorophenol		73									38			13	124	100%	0%	Excellent

Table 4-12
Summary of Analytical Completeness and Data Quality

Analyte	Number of Results Qualified[1]														Total Number of Results[3]	% Analytical Completeness[4]	% Unusable Data[5]	Qualitative Data Quality
	Unqualified Positive Results	U	U[2]	NJ	G	J/JG	JL/ JLG	JH/ JHG	EMPC	UJ	UL	R	M	UM				
2,4-Dichlorophenol		84			1						20			19	124	100%	0%	Excellent
2,4-Dimethylphenol		99			1									24	124	100%	0%	Excellent
2,4-Dinitrophenol		100												24	124	100%	0%	Excellent
2,4-Dinitrotoluene		75								26				23	124	100%	0%	Excellent
2,6-Dinitrotoluene		100												24	124	100%	0%	Excellent
2-Chloronaphthalene		99									1			24	124	100%	0%	Excellent
2-Chlorophenol		75									36			13	124	100%	0%	Excellent
2-Methylnaphthalene	3	27			35		27				27		1	4	124	100%	0%	Excellent
2-Methylphenol		89									18			17	124	100%	0%	Excellent
2-Nitroaniline		90								7	3			24	124	100%	0%	Excellent
2-Nitrophenol		100												24	124	100%	0%	Excellent
3,3'-Dichlorobenzidine		12								2	103			7	124	100%	0%	Excellent
3&4-Methylphenol		58			2		2				52			10	124	100%	0%	Excellent
3-Nitroaniline		45									67			12	124	100%	0%	Excellent
4,6-Dinitro-2-methylphenol		47								61				16	124	100%	0%	Excellent
4-Bromophenyl-phenylether		100												24	124	100%	0%	Excellent
4-Chloro-3-Methylphenol		74									37			13	124	100%	0%	Excellent
4-Chloroaniline		1					3				119			1	124	100%	0%	Excellent
4-Chlorophenyl-phenylether		71								30	2			21	124	100%	0%	Excellent
4-Nitroaniline		52								32	26			14	124	100%	0%	Excellent
4-Nitrophenol		71									35			18	124	100%	0%	Excellent
Acenaphthene	20	41			53								7	3	124	100%	0%	Excellent
Acenaphthylene	8	43			71									2	124	100%	0%	Excellent
Anthracene	32	40			40								11	1	124	100%	0%	Excellent
Benzo(a)anthracene	43	32			28	1							20		124	100%	0%	Excellent
Benzo(a)pyrene	34	32			29	9				1			18	1	124	100%	0%	Excellent
Benzo(b)fluoranthene	36	36			25	8				1			17	1	124	100%	0%	Excellent
Benzo(g,h,i)perylene	12	19			25	15	26			1	19		6	1	124	100%	0%	Excellent
Benzo(k)fluoranthene	15	38			54	9				1			6	1	124	100%	0%	Excellent
bis(2-Chloroethoxy)methane		59									54			11	124	100%	0%	Excellent
bis(2-Chloroethyl)ether		73									38			13	124	100%	0%	Excellent
bis(2-Ethylhexyl)phthalate	9	48			26	7	5			1	14		6	8	124	100%	0%	Excellent
Butylbenzylphthalate		42			17	2	2			2	46			13	124	100%	0%	Excellent
Carbazole	2	54			43		6				13			6	124	100%	0%	Excellent
Chrysene	38	31			30	6				1			18		124	100%	0%	Excellent
Di-n-Butylphthalate		83			2						19			20	124	100%	0%	Excellent
Di-n-Octylphthalate		98			1					1				24	124	100%	0%	Excellent
Dibenzo(a,h)anthracene	2	29			42	13	18			1	17			2	124	100%	0%	Excellent
Dibenzofuran	6	41			51		7				12			7	124	100%	0%	Excellent
Diethylphthalate		85									19			20	124	100%	0%	Excellent
Dimethylphthalate		85									19			20	124	100%	0%	Excellent
Fluoranthene	44	32			24	3							21		124	100%	0%	Excellent
Fluorene	10	48			43	15				3			2	3	124	100%	0%	Excellent

Table 4-12
Summary of Analytical Completeness and Data Quality

Analyte	Number of Results Qualified[1]														Total Number of Results[3]	% Analytical Completeness[4]	% Unusable Data[5]	Qualitative Data Quality
	Unqualified Positive Results	U	U[2]	NJ	G	J/JG	JL/ JLG	JH/ JHG	EMPC	UJ	UL	R	M	UM				
Hexachlorobenzene		99			1									24	124	100%	0%	Excellent
Hexachlorobutadiene		100												24	124	100%	0%	Excellent
Hexachlorocyclopentadiene		20								72	20	4		8	124	97%	3%	Very Good
Hexachloroethane		59									54			11	124	100%	0%	Excellent
Indeno(1,2,3-cd)pyrene	14	23			31	15	19			1	16		5		124	100%	0%	Excellent
Isophorone		73									38			13	124	100%	0%	Excellent
N-Nitroso-di-n-propylamine		59									54			11	124	100%	0%	Excellent
N-Nitrosodiphenylamine		71									35			18	124	100%	0%	Excellent
Naphthalene	10	31			40		22				16		1	4	124	100%	0%	Excellent
Nitrobenzene		85									19			20	124	100%	0%	Excellent
Pentachlorophenol		29									86			9	124	100%	0%	Excellent
Phenanthrene	36	33			43								12		124	100%	0%	Excellent
Phenol		87			1						19			17	124	100%	0%	Excellent
Pyrene	26	15			15	8	32			1	15		11	1	124	100%	0%	Excellent
Pesticides																		
4,4'-DDD	22	41		3	22	18	1						12	5	124	100%	0%	Excellent
4,4'-DDE	12	59		1	15	21						1	9	6	124	99%	1%	Very Good
4,4'-DDT	3	81			4	9				6		2	7	12	124	98%	2%	Very Good
Aldrin		88			11	3	1	1				1	2	17	124	99%	1%	Very Good
Alpha-BHC	1	33			40	27	2	1		7		2	2	9	124	98%	2%	Very Good
Alpha-Chlordane	6	70			21	9						2	7	9	124	98%	2%	Very Good
Beta-BHC	1	97										2	1	23	124	98%	2%	Very Good
Delta-BHC		89			4	9	1					2		19	124	98%	2%	Very Good
Dieldrin	10	58		1	23	18		1					10	3	124	100%	0%	Excellent
Endosulfan I	1	76		2	6	16	1	1				1	1	19	124	99%	1%	Very Good
Endosulfan II	4	83			12	5						2	3	15	124	98%	2%	Very Good
Endosulfan Sulfate		95			3	2						1	2	21	124	99%	1%	Very Good
Endrin	9	71			16	12						1	5	10	124	99%	1%	Very Good
Endrin Aldehyde	11	56		7	11	22						2	7	8	124	98%	2%	Very Good
Endrin Ketone	1	92			2	9	1	1					1	17	124	100%	0%	Excellent
Gamma-BHC (Lindane)		94			1	1	1	2				1		24	124	99%	1%	Very Good
Gamma-Chlordane	3	72			15	17	1					2	10	4	124	98%	2%	Very Good
Heptachlor		90			7	3	4	1				1		18	124	99%	1%	Very Good
Heptachlor Epoxide	1	87			6	4	4	1			1	1	3	16	124	99%	1%	Very Good
Methoxychlor	1	90			4	2				2		2		23	124	98%	2%	Very Good
Toxaphene		98										2		24	124	98%	2%	Very Good
Aroclors PCBs																		
Aroclor-1016		100									2	1		21	124	99%	1%	Very Good
Aroclor-1221		100									2	1		21	124	99%	1%	Very Good
Aroclor-1232		100									2	1		21	124	99%	1%	Very Good
Aroclor-1242	11	88						1			2	1	9	12	124	99%	1%	Very Good
Aroclor-1248	5	92			2			1			2	1	3	18	124	99%	1%	Very Good

Table 4-12
Summary of Analytical Completeness and Data Quality

Analyte	Number of Results Qualified[1]														Total Number of Results[3]	% Analytical Completeness[4]	% Unusable Data[5]	Qualitative Data Quality
	Unqualified Positive Results	U	U[2]	NJ	G	J/JG	JL/ JLG	JH/ JHG	EMPC	UJ	UL	R	M	UM				
Aroclor-1254	8	89			3						2	1	9	12	124	99%	1%	Very Good
Aroclor-1260	3	95			2						2	1	4	17	124	99%	1%	Very Good
Aroclor-1262		100									2	1		21	124	99%	1%	Very Good
Aroclor-1268		100									2	1		21	124	99%	1%	Very Good
Herbicides																		
2,4,5-T		76									34			14	124	100%	0%	Excellent
2,4,5-TP		47									67			10	124	100%	0%	Excellent
2,4-D		84									17			23	124	100%	0%	Excellent
2,4-DB		84									17			23	124	100%	0%	Excellent
Dioxins/Furans																		
1,2,3,4,6,7,8-HpCDD	87	1			8	3			2		1		22		124	100%	0%	Excellent
1,2,3,4,6,7,8-HpCDF	59	8	15		12	5		1	4				20		124	100%	0%	Excellent
1,2,3,4,7,8,9-HpCDF	31	39			32	3	1		1		1		15	1	124	100%	0%	Excellent
1,2,3,4,7,8-HxCDD	10	17			81				5				11		124	100%	0%	Excellent
1,2,3,4,7,8-HxCDF	55	22	1		18	5			3				20		124	100%	0%	Excellent
1,2,3,6,7,8-HxCDD	25	7			76	1			3				12		124	100%	0%	Excellent
1,2,3,6,7,8-HxCDF	39	35			26	4			1				18	1	124	100%	0%	Excellent
1,2,3,7,8,9-HxCDD	16	11			82				3				12		124	100%	0%	Excellent
1,2,3,7,8,9-HxCDF	24	51			33	2							13	1	124	100%	0%	Excellent
1,2,3,7,8-PeCDD	11	20			77				5				11		124	100%	0%	Excellent
1,2,3,7,8-PeCDF	23	37			40				5				18	1	124	100%	0%	Excellent
2,3,4,6,7,8-HxCDF	31	36			37	2					1		16	1	124	100%	0%	Excellent
2,3,4,7,8-PeCDF	36	35			29	4							20		124	100%	0%	Excellent
2,3,7,8-TCDD	52	33			10	3			8				18		124	100%	0%	Excellent
2,3,7,8-TCDF	43	36		4	15				5				21		124	100%	0%	Excellent
OCDD	95					3	3	1					22		124	100%	0%	Excellent
OCDF	56	13	11		14	6	2	1	1				20		124	100%	0%	Excellent
Total HpCDD	101					1							22		124	100%	0%	Excellent
Total HpCDF	75	8	13			2			4				22		124	100%	0%	Excellent
Total HxCDD	100	1				2							21		124	100%	0%	Excellent
Total HxCDF	89	5				2			6				22		124	100%	0%	Excellent
Total PeCDD	99	2				2							21		124	100%	0%	Excellent
Total PeCDF	81	6				2			13				22		124	100%	0%	Excellent
Total TCDD	98	3				1							22		124	100%	0%	Excellent
Total TCDF	95	4				1			2				22		124	100%	0%	Excellent
Congener PCBs																		
PCB-1	49	38	10		3	5			1				17	1	124	100%	0%	Excellent
PCB-100	46	49			6	2							13	8	124	100%	0%	Excellent
PCB-103	45	51			5	2							12	9	124	100%	0%	Excellent
PCB-104	10	85			9								9	11	124	100%	0%	Excellent
PCB-105	67	28			4	5							16	4	124	100%	0%	Excellent
PCB-106/118	74	21			7	3							17	2	124	100%	0%	Excellent

Table 4-12
Summary of Analytical Completeness and Data Quality

Analyte	Number of Results Qualified[1]														Total Number of Results[3]	% Analytical Completeness[4]	% Unusable Data[5]	Qualitative Data Quality
	Unqualified Positive Results	U	U[2]	NJ	G	J/JG	JL/ JLG	JH/ JHG	EMPC	UJ	UL	R	M	UM				
PCB-107/109	55	40			6	3							12	8	124	100%	0%	Excellent
PCB-108/112	55	42			4	3							13	7	124	100%	0%	Excellent
PCB-11	64	32	3		3	2							15	5	124	100%	0%	Excellent
PCB-110	76	21			4	3							17	3	124	100%	0%	Excellent
PCB-111/115	45	50			4	3			1				12	9	124	100%	0%	Excellent
PCB-113	26	69			6	3							10	10	124	100%	0%	Excellent
PCB-114	44	52			5	2							13	8	124	100%	0%	Excellent
PCB-119	51	44			6	3							13	7	124	100%	0%	Excellent
PCB-12/13	57	41			2	2							15	7	124	100%	0%	Excellent
PCB-120	31	62			9								12	10	124	100%	0%	Excellent
PCB-121	1	101												22	124	100%	0%	Excellent
PCB-122	40	53			7	3							13	8	124	100%	0%	Excellent
PCB-123	46	52			3	2							13	8	124	100%	0%	Excellent
PCB-124	47	47			4	3			2				13	8	124	100%	0%	Excellent
PCB-126	37	58			7								14	8	124	100%	0%	Excellent
PCB-127	7	91			3				1				2	20	124	100%	0%	Excellent
PCB-128/162	58	35			5	4			2				15	5	124	100%	0%	Excellent
PCB-129	47	46			4	3			2				14	8	124	100%	0%	Excellent
PCB-130	50	46			3	4							13	8	124	100%	0%	Excellent
PCB-131	13	80			14								5	12	124	100%	0%	Excellent
PCB-132/161	65	31			3	4							14	7	124	100%	0%	Excellent
PCB-133/142	48	47			5	2							13	9	124	100%	0%	Excellent
PCB-134/143	51	45			4	3							13	8	124	100%	0%	Excellent
PCB-135	58	39			3	4							14	6	124	100%	0%	Excellent
PCB-136	59	39			2	4			1				14	5	124	100%	0%	Excellent
PCB-137	48	46			4	2			2				14	8	124	100%	0%	Excellent
PCB-138/163/164	73	21	1		5	2			1				18	3	124	100%	0%	Excellent
PCB-139/149	71	22	2		3	3			2				17	4	124	100%	0%	Excellent
PCB-14	6	94			2								1	21	124	100%	0%	Excellent
PCB-140	33	60			6	1			3				13	8	124	100%	0%	Excellent
PCB-141	63	34			4	3							15	5	124	100%	0%	Excellent
PCB-144	50	45			5	3							13	8	124	100%	0%	Excellent
PCB-145	6	88			14				1				1	14	124	100%	0%	Excellent
PCB-146/165	63	34			2	3			1				15	6	124	100%	0%	Excellent
PCB-147	49	48			4	1							14	8	124	100%	0%	Excellent
PCB-148	28	66			8								14	8	124	100%	0%	Excellent
PCB-15	72	27				4							19	2	124	100%	0%	Excellent
PCB-150	36	62			4								14	8	124	100%	0%	Excellent
PCB-151	64	32			4	4			1				14	5	124	100%	0%	Excellent
PCB-152	15	75			13				1				9	11	124	100%	0%	Excellent
PCB-153	72	23	1		4	3							18	3	124	100%	0%	Excellent
PCB-154	48	49			5	1							14	7	124	100%	0%	Excellent
PCB-155	30	65			6				1				14	8	124	100%	0%	Excellent

Table 4-12
Summary of Analytical Completeness and Data Quality

Analyte	Number of Results Qualified[1]														Total Number of Results[3]	% Analytical Completeness[4]	% Unusable Data[5]	Qualitative Data Quality
	Unqualified Positive Results	U	U[2]	NJ	G	J/JG	JL/ JLG	JH/ JHG	EMPC	UJ	UL	R	M	UM				
PCB-156	54	39			7	3			1				13	7	124	100%	0%	Excellent
PCB-157	43	53			4	1			1				14	8	124	100%	0%	Excellent
PCB-158/160	56	38			3	4			2				13	8	124	100%	0%	Excellent
PCB-159	37	56			2	3			3	1			14	8	124	100%	0%	Excellent
PCB-16/32	75	24				4							16	5	124	100%	0%	Excellent
PCB-166	36	61			5								14	8	124	100%	0%	Excellent
PCB-167	48	44			6	3			1				14	8	124	100%	0%	Excellent
PCB-168	23	71			8								13	9	124	100%	0%	Excellent
PCB-169	4	94			4									22	124	100%	0%	Excellent
PCB-17	70	27			2	4							15	6	124	100%	0%	Excellent
PCB-170	61	32			3	4			3				15	6	124	100%	0%	Excellent
PCB-171	52	44			2	3			1				14	8	124	100%	0%	Excellent
PCB-172	49	45			4	2			2				14	8	124	100%	0%	Excellent
PCB-173	34	63			3				3				13	8	124	100%	0%	Excellent
PCB-174	65	32			3	3							15	6	124	100%	0%	Excellent
PCB-175	44	53			2	2			1				14	8	124	100%	0%	Excellent
PCB-176	46	49			4	2			1				14	8	124	100%	0%	Excellent
PCB-177	63	34			3	3							15	6	124	100%	0%	Excellent
PCB-178	52	43			4	3							14	8	124	100%	0%	Excellent
PCB-179	60	35			5	3							15	6	124	100%	0%	Excellent
PCB-18	70	22	5			6					1		16	4	124	100%	0%	Excellent
PCB-180	67	24	4		3	3			1				18	4	124	100%	0%	Excellent
PCB-181	22	69			12	1							11	9	124	100%	0%	Excellent
PCB-182/187	68	28			5	3							15	5	124	100%	0%	Excellent
PCB-183	62	33			6	3							15	5	124	100%	0%	Excellent
PCB-184	16	75			13				1				10	9	124	100%	0%	Excellent
PCB-185	48	47			3	3			1				14	8	124	100%	0%	Excellent
PCB-186	5	94			7				1				1	16	124	100%	0%	Excellent
PCB-188	19	73			10				1				13	8	124	100%	0%	Excellent
PCB-189	43	54			4	1							14	8	124	100%	0%	Excellent
PCB-19	55	43			1	4							13	8	124	100%	0%	Excellent
PCB-190	51	45			3	3							14	8	124	100%	0%	Excellent
PCB-191	41	55			4	2							14	8	124	100%	0%	Excellent
PCB-192	9	90			6								3	16	124	100%	0%	Excellent
PCB-193	48	50			2	2							14	8	124	100%	0%	Excellent
PCB-194	63	31			5	4							15	6	124	100%	0%	Excellent
PCB-195	50	44			5	3							14	8	124	100%	0%	Excellent
PCB-196/203	65	29			4	3			3				15	5	124	100%	0%	Excellent
PCB-197	39	59			3				1				14	8	124	100%	0%	Excellent
PCB-198	43	53			4	1			1				12	10	124	100%	0%	Excellent

Table 4-12
Summary of Analytical Completeness and Data Quality

Analyte	Number of Results Qualified[1]														Total Number of Results[3]	% Analytical Completeness[4]	% Unusable Data[5]	Qualitative Data Quality
	Unqualified Positive Results	U	U[2]	NJ	G	J/JG	JL/ JLG	JH/ JHG	EMPC	UJ	UL	R	M	UM				
PCB-199	65	31			3	3		1	1				15	5	124	100%	0%	Excellent
PCB-2	91	7				5							21		124	100%	0%	Excellent
PCB-20/21/33	70	26			1	6							16	5	124	100%	0%	Excellent
PCB-200	47	49			4	2							14	8	124	100%	0%	Excellent
PCB-201	49	45			6	2							14	8	124	100%	0%	Excellent
PCB-202	51	42			5	3			1				14	8	124	100%	0%	Excellent
PCB-204	13	83			10								6	12	124	100%	0%	Excellent
PCB-205	41	55			5	1							14	8	124	100%	0%	Excellent
PCB-206	65	32			4	2			1				15	5	124	100%	0%	Excellent
PCB-207	46	50			6	2							13	7	124	100%	0%	Excellent
PCB-208	51	43			7	2							14	7	124	100%	0%	Excellent
PCB-209	62	33			5	3			2				19		124	100%	0%	Excellent
PCB-22	69	26			3	5							16	5	124	100%	0%	Excellent
PCB-23	19	73			12	1							8	11	124	100%	0%	Excellent
PCB-24/27	59	40			2	3							13	7	124	100%	0%	Excellent
PCB-25	64	34			3	3							14	6	124	100%	0%	Excellent
PCB-26	69	30			1	3							16	5	124	100%	0%	Excellent
PCB-28	81	19				3							17	4	124	100%	0%	Excellent
PCB-29	37	59			5	1				1			13	8	124	100%	0%	Excellent
PCB-3	77	16			4	5			2				20		124	100%	0%	Excellent
PCB-30	15	84			5								6	14	124	100%	0%	Excellent
PCB-31	80	20				3							17	4	124	100%	0%	Excellent
PCB-34	41	59			1	2							13	8	124	100%	0%	Excellent
PCB-35	45	49			3	5			2				12	8	124	100%	0%	Excellent
PCB-36	14	76			12								12	10	124	100%	0%	Excellent
PCB-37	70	27			3	4							16	4	124	100%	0%	Excellent
PCB-38	43	57			2	1							13	8	124	100%	0%	Excellent
PCB-39	33	63			6								13	9	124	100%	0%	Excellent
PCB-4/10	50	47				6							13	8	124	100%	0%	Excellent
PCB-40	63	30			5	4			1		2		14	5	124	100%	0%	Excellent
PCB-41/64/71/72	71	20			5	6		1					17	4	124	100%	0%	Excellent
PCB-42/59	69	27			2	5	1						16	4	124	100%	0%	Excellent
PCB-43/49	75	19			3	5			1				17	4	124	100%	0%	Excellent
PCB-44	72	23			3	4		1					17	4	124	100%	0%	Excellent
PCB-45	63	33			3	4							15	6	124	100%	0%	Excellent
PCB-46	57	40			3	4							13	7	124	100%	0%	Excellent
PCB-47	73	26				4							17	4	124	100%	0%	Excellent
PCB-48/75	67	30			2	4							15	6	124	100%	0%	Excellent
PCB-5/8	62	34			4	4							15	5	124	100%	0%	Excellent
PCB-50	29	68			4	2							12	9	124	100%	0%	Excellent
PCB-51	57	37			4	4			1				13	8	124	100%	0%	Excellent
PCB-52/69	76	16	5		4	5							17	1	124	100%	0%	Excellent

Table 4-12
Summary of Analytical Completeness and Data Quality

Analyte	Number of Results Qualified[1]														Total Number of Results[3]	% Analytical Completeness[4]	% Unusable Data[5]	Qualitative Data Quality
	Unqualified Positive Results	U	U[2]	NJ	G	J/JG	JL/ JLG	JH/ JHG	EMPC	UJ	UL	R	M	UM				
PCB-53	65	32			2	4							15	6	124	100%	0%	Excellent
PCB-54	38	59			4	2							11	10	124	100%	0%	Excellent
PCB-55	41	53			6	3							12	9	124	100%	0%	Excellent
PCB-56/60	71	22			5	5							17	4	124	100%	0%	Excellent
PCB-57	37	57			6	3							13	8	124	100%	0%	Excellent
PCB-58	35	60			6				1				14	8	124	100%	0%	Excellent
PCB-6	53	44			1	5							13	8	124	100%	0%	Excellent
PCB-61/70	74	19			6	5							17	3	124	100%	0%	Excellent
PCB-62	10	86			7								6	15	124	100%	0%	Excellent
PCB-63	49	46			4	4			1				13	7	124	100%	0%	Excellent
PCB-65	19	78			5					1			9	12	124	100%	0%	Excellent
PCB-67	49	46			5	4							13	7	124	100%	0%	Excellent
PCB-68	39	57			5	2					1		13	7	124	100%	0%	Excellent
PCB-7/9	45	52			1	5							13	8	124	100%	0%	Excellent
PCB-73	1	99				2								22	124	100%	0%	Excellent
PCB-74	70	25			3	6							16	4	124	100%	0%	Excellent
PCB-76/66	72	22			5	5							17	3	124	100%	0%	Excellent
PCB-77	61	31			8	5	1						15	3	124	100%	0%	Excellent
PCB-78	19	75			4	2			5	1			10	8	124	100%	0%	Excellent
PCB-79	10	51			3				47				5	8	124	100%	0%	Excellent
PCB-80	4	97				1								22	124	100%	0%	Excellent
PCB-81	31	60			9	3							13	8	124	100%	0%	Excellent
PCB-82	60	35			3	5							14	7	124	100%	0%	Excellent
PCB-83	19	74			11								12	8	124	100%	0%	Excellent
PCB-84/92	71	25			4	4							15	5	124	100%	0%	Excellent
PCB-85/116	65	31			5	3			1				14	5	124	100%	0%	Excellent
PCB-86	38	58			3	2			2				11	10	124	100%	0%	Excellent
PCB-87/117/125	70	28			2	4			1				14	5	124	100%	0%	Excellent
PCB-88/91	65	32			3	3			2				14	5	124	100%	0%	Excellent
PCB-89	41	54			4	4							13	8	124	100%	0%	Excellent
PCB-90/101	79	16			5	4			1				17	2	124	100%	0%	Excellent
PCB-93		102												22	124	100%	0%	Excellent
PCB-94	40	56			4	3							13	8	124	100%	0%	Excellent
PCB-95/98/102	75	23			2	3							17	4	124	100%	0%	Excellent
PCB-96	40	54			5	2			1		2		13	7	124	100%	0%	Excellent
PCB-97	70	28			2	3			1				15	5	124	100%	0%	Excellent
PCB-99	71	26			3	3	1						16	4	124	100%	0%	Excellent
Total decaCB	66	33				2			2				21		124	100%	0%	Excellent
Total diCB	75	26				1							20	2	124	100%	0%	Excellent
Total heptaCB	68	23				1			12				16	4	124	100%	0%	Excellent
Total hexaCB	67	19				1			17				17	3	124	100%	0%	Excellent
Total monoCB	92	5				3			2				22		124	100%	0%	Excellent
Total nonaCB	68	32				1			1				17	5	124	100%	0%	Excellent

Table 4-12
Summary of Analytical Completeness and Data Quality

Analyte	Number of Results Qualified[1]														Total Number of Results[3]	% Analytical Completeness[4]	% Unusable Data[5]	Qualitative Data Quality
	Unqualified Positive Results	U	U[2]	NJ	G	J/JG	JL/ JLG	JH/ JHG	EMPC	UJ	UL	R	M	UM				
Total octaCB	68	28				1			5				17	5	124	100%	0%	Excellent
Total PCB	49								66				9		124	100%	0%	Excellent
Total pentaCB	73	15				1			14				19	2	124	100%	0%	Excellent
Total tetraCB	48	14							49				12	1	124	100%	0%	Excellent
Total triCB	79	18	2			1			2				18	4	124	100%	0%	Excellent
Inorganics																		
Aluminum	99					1							24		124	100%	0%	Excellent
Antimony			9				12				103				124	100%	0%	Excellent
Arsenic	85					19							20		124	100%	0%	Excellent
Barium	99					1							24		124	100%	0%	Excellent
Beryllium	4	2	96			19		3							124	100%	0%	Excellent
Cadmium	11	26	7				13				59		5	3	124	100%	0%	Excellent
Calcium	70					39							15		124	100%	0%	Excellent
Chromium	69					21		18					16		124	100%	0%	Excellent
Cobalt	85					19							20		124	100%	0%	Excellent
Copper	98					2							24		124	100%	0%	Excellent
Cyanide	4	14	30			6	8				58			4	124	100%	0%	Excellent
Hexavalent Chromium	45	25	39			6	1			5	2		1		124	100%	0%	Excellent
Iron	85					19							20		124	100%	0%	Excellent
Lead	49					21	44						10		124	100%	0%	Excellent
Magnesium	85					19							20		124	100%	0%	Excellent
Manganese	70					19		19					16		124	100%	0%	Excellent
Mercury	86	3				2	10						23		124	100%	0%	Excellent
Nickel	85					19							20		124	100%	0%	Excellent
Potassium	100												24		124	100%	0%	Excellent
Selenium	34	17	9			12	7	28			1		16		124	100%	0%	Excellent
Silver	32	37	33										22		124	100%	0%	Excellent
Sodium	91					10							23		124	100%	0%	Excellent
Thallium		84	9								16		1	14	124	100%	0%	Excellent
Vanadium	100												24		124	100%	0%	Excellent
Zinc	70		2			37							15		124	100%	0%	Excellent
AVS/SEM																		
Acid Volatile Sulfide	15	15				2	3			1	2		14	4	56	100%	0%	Excellent
Cadmium	10						27	5			6		8		56	100%	0%	Excellent
Copper	6	1				40	1	5					3		56	100%	0%	Excellent
Lead	8					43	2						3		56	100%	0%	Excellent
Mercury	8	19	15										3	11	56	100%	0%	Excellent
Nickel	5					44		7							56	100%	0%	Excellent
Silver		4	2			10	28				11	1			56	98%	2%	Very Good
Zinc	4					49							3		56	100%	0%	Excellent

Table 4-12
Summary of Analytical Completeness and Data Quality

Analyte	Number of Results Qualified[1]														Total Number of Results[3]	% Analytical Completeness[4]	% Unusable Data[5]	Qualitative Data Quality
	Unqualified Positive Results	U	U[2]	NJ	G	J/JG	JL/ JLG	JH/ JHG	EMPC	UJ	UL	R	M	UM				
Miscellaneous																		
pH	105												19		124	100%	0%	Excellent
ORP	82					10		13					19		124	100%	0%	Excellent
TOC	80	5				11	6	7		1			14		124	100%	0%	Excellent
TEPH	62	2			22	13	1	5					19		124	100%	0%	Excellent
Grain Size																		
0.001 mm	88	15											17	2	122	100%	0%	Excellent
0.002 mm	93	10											18	1	122	100%	0%	Excellent
0.005 mm	96	6				1							18	1	122	100%	0%	Excellent
0.02 mm	101	2											18	1	122	100%	0%	Excellent
0.05 mm	103												18	1	122	100%	0%	Excellent
0.064 mm	103												18	1	122	100%	0%	Excellent
0.075 mm	102					1							19		122	100%	0%	Excellent
0.15 mm	103												19		122	100%	0%	Excellent
0.3 mm	103												19		122	100%	0%	Excellent
0.6 mm	103												19		122	100%	0%	Excellent
1.18 mm	103												19		122	100%	0%	Excellent
19 mm	103												19		122	100%	0%	Excellent
2.36 mm	103												19		122	100%	0%	Excellent
3.35 mm	103												19		122	100%	0%	Excellent
37.5 mm	103												19		122	100%	0%	Excellent
4.75 mm	103												19		122	100%	0%	Excellent
75 mm	103												19		122	100%	0%	Excellent
Radiochemistry																		
Lead-210	58														58	100%	0%	Excellent
Beryllium-7		5						1							6	100%	0%	Excellent
Cesium-137		58													58	100%	0%	Excellent

Notes:
1. VOCs - Volatile Organic Compounds
2. SVOCs - Semivolatile Organic Compounds
3. PCBs - Polychlorinated Biphenyls
4. AVS/SEM - Acid Volatile Sulfide/Simultaneous Extractable Metals
5. ORP - Oxidation Reduction Potential
6. TOC - Total Organic Carbon
7. TEPH - Total Extractable Petroleum Hydrocarbons

[1] Results are the number of individual analytes in the analysis fraction. For example, there are 33 analytes in the Volatile Organic analysis fraction.
[2] Reported positive results qualified as "not-detected" and flagged "U" due to blank contamination.
[3] Total Number of Results is the summation of all qualified and unqualified results.
[4] Percent Analytical Completeness is the ratio of the valid results to the Total Number of Results (RIWP, Section 5.2.2.3).
[5] Percent Unusable Data is the ratio of the results qualified R to the Total Number of Results.

Table 4-13
Summary of Field Duplicate Results

Analyte	Total Number of Field Duplicate Pairs	Total Number of Field Duplicate Pairs with Non-Detects for Both Samples	Total Number of Field Duplicate Pairs with Positives in Either Sample					Overall Percent of Samples that Met the Criteria
			Total Number of Samples	Number of Samples that Met the Criteria[1]	Number of Samples that Did Not Meet the Criteria	Percent of Samples that Met the Criteria	Percent of Samples that Did Not Meet the Criteria	
VOCs								
1,1,1-Trichloroethane	8	8	0	0	0	NA	NA	100
1,1,2,2-Tetrachloroethane	8	8	0	0	0	NA	NA	100
1,1,2-Trichloroethane	8	8	0	0	0	NA	NA	100
1,1-Dichloroethane	8	8	0	0	0	NA	NA	100
1,1-Dichloroethene	8	8	0	0	0	NA	NA	100
1,2-Dichloroethane	8	8	0	0	0	NA	NA	100
1,2-Dichloroethene (total)	8	8	0	0	0	NA	NA	100
1,2-Dichloropropane	8	8	0	0	0	NA	NA	100
2-Butanone	8	6	2	1	1	50	50	88
2-Hexanone	8	8	0	0	0	NA	NA	100
4-Methyl-2-pentanone	8	8	0	0	0	NA	NA	100
Acetone	8	5	3	3	0	100	0	100
Benzene	8	8	0	0	0	NA	NA	100
Bromodichloromethane	8	8	0	0	0	NA	NA	100
Bromoform	8	8	0	0	0	NA	NA	100
Bromomethane	8	8	0	0	0	NA	NA	100
Carbon Disulfide	8	7	1	1	0	100	0	100
Carbon Tetrachloride	8	8	0	0	0	NA	NA	100
Chlorobenzene	8	8	0	0	0	NA	NA	100
Chloroethane	8	8	0	0	0	NA	NA	100
Chloroform	8	7	1	1	0	100	0	100
Chloromethane	8	8	0	0	0	NA	NA	100
cis-1,3-Dichloropropene	8	8	0	0	0	NA	NA	100
Dibromochloromethane	8	8	0	0	0	NA	NA	100
Ethylbenzene	8	7	1	1	0	100	0	100
Methylene Chloride	8	8	0	0	0	NA	NA	100
Styrene	8	8	0	0	0	NA	NA	100
Tetrachloroethene	8	8	0	0	0	NA	NA	100
Toluene	8	6	2	2	0	100	0	100
trans-1,3-Dichloropropene	8	8	0	0	0	NA	NA	100
Trichloroethene	8	8	0	0	0	NA	NA	100
Vinyl Chloride	8	8	0	0	0	NA	NA	100
Xylenes (total)	8	7	1	1	0	100	0	100
All Results[1]	264	253	11	10	1	91	9	100

Table 4-13
Summary of Field Duplicate Results

Analyte	Total Number of Field Duplicate Pairs	Total Number of Field Duplicate Pairs with Non-Detects for Both Samples	Total Number of Field Duplicate Pairs with Positives in Either Sample					Overall Percent of Samples that Met the Criteria
			Total Number of Samples	Number of Samples that Met the Criteria[1]	Number of Samples that Did Not Meet the Criteria	Percent of Samples that Met the Criteria	Percent of Samples that Did Not Meet the Criteria	
SVOCs								
1,2,4-Trichlorobenzene	8	7	1	1	0	100	0	100
1,2-Dichlorobenzene	8	6	2	2	0	100	0	100
1,3-Dichlorobenzene	8	7	1	1	0	100	0	100
1,4-Dichlorobenzene	8	4	4	4	0	100	0	100
2,2'-oxybis(1-Chloropropane)	8	8	0	0	0	NA	NA	100
2,4,5-Trichlorophenol	8	8	0	0	0	NA	NA	100
2,4,6-Trichlorophenol	8	8	0	0	0	NA	NA	100
2,4-Dichlorophenol	8	8	0	0	0	NA	NA	100
2,4-Dimethylphenol	8	8	0	0	0	NA	NA	100
2,4-Dinitrophenol	8	8	0	0	0	NA	NA	100
2,4-Dinitrotoluene	8	8	0	0	0	NA	NA	100
2,6-Dinitrotoluene	8	8	0	0	0	NA	NA	100
2-Chloronaphthalene	8	8	0	0	0	NA	NA	100
2-Chlorophenol	8	8	0	0	0	NA	NA	100
2-Methylnaphthalene	8	1	7	7	0	100	0	100
2-Methylphenol	8	8	0	0	0	NA	NA	100
2-Nitroaniline	8	8	0	0	0	NA	NA	100
2-Nitrophenol	8	8	0	0	0	NA	NA	100
3,3'-Dichlorobenzidine	8	8	0	0	0	NA	NA	100
3&4-Methylphenol	8	8	0	0	0	NA	NA	100
3-Nitroaniline	8	8	0	0	0	NA	NA	100
4,6-Dinitro-2-methylphenol	8	8	0	0	0	NA	NA	100
4-Bromophenyl-phenylether	8	8	0	0	0	NA	NA	100
4-Chloro-3-Methylphenol	8	8	0	0	0	NA	NA	100
4-Chloroaniline	8	8	0	0	0	NA	NA	100
4-Chlorophenyl-phenylether	8	8	0	0	0	NA	NA	100
4-Nitroaniline	8	8	0	0	0	NA	NA	100
4-Nitrophenol	8	8	0	0	0	NA	NA	100
Acenaphthene	8	0	8	8	0	100	0	100
Acenaphthylene	8	0	8	8	0	100	0	100
Anthracene	8	0	8	8	0	100	0	100
Benzo(a)anthracene	8	0	8	6	2	75	25	75
Benzo(a)pyrene	8	0	8	7	1	88	13	88
Benzo(b)fluoranthene	8	0	8	7	1	88	13	88
Benzo(g,h,i)perylene	8	0	8	8	0	100	0	100
Benzo(k)fluoranthene	8	0	8	8	0	100	0	100

Table 4-13
Summary of Field Duplicate Results

Analyte	Total Number of Field Duplicate Pairs	Total Number of Field Duplicate Pairs with Non-Detects for Both Samples	Total Number of Field Duplicate Pairs with Positives in Either Sample					Overall Percent of Samples that Met the Criteria
			Total Number of Samples	Number of Samples that Met the Criteria[1]	Number of Samples that Did Not Meet the Criteria	Percent of Samples that Met the Criteria	Percent of Samples that Did Not Meet the Criteria	
bis(2-Chloroethoxy)methane	8	8	0	0	0	NA	NA	100
bis(2-Chloroethyl)ether	8	8	0	0	0	NA	NA	100
bis(2-Ethylhexyl)phthalate	8	1	7	7	0	100	0	100
Butylbenzylphthalate	8	6	2	2	0	100	0	100
Carbazole	8	1	7	7	0	100	0	100
Chrysene	8	0	8	7	1	88	13	88
Di-n-Butylphthalate	8	0	8	8	0	100	0	100
Di-n-Octylphthalate	8	0	8	8	0	100	0	100
Dibenzo(a,h)anthracene	8	8	0	0	0	NA	NA	100
Dibenzofuran	8	8	0	0	0	NA	NA	100
Diethylphthalate	8	8	0	0	0	NA	NA	100
Dimethylphthalate	8	8	0	0	0	NA	NA	100
Fluoranthene	8	0	8	4	4	50	50	50
Fluorene	8	0	8	8	0	100	0	100
Hexachlorobenzene	8	8	0	0	0	NA	NA	100
Hexachlorobutadiene	8	8	0	0	0	NA	NA	100
Hexachlorocyclopentadiene	8	8	0	0	0	NA	NA	100
Hexachloroethane	8	8	0	0	0	NA	NA	100
Indeno(1,2,3-cd)pyrene	8	0	8	8	0	100	0	100
Isophorone	8	8	0	0	0	NA	NA	100
N-Nitroso-di-n-propylamine	8	0	8	8	0	100	0	100
N-Nitrosodiphenylamine	8	8	0	0	0	NA	NA	100
Naphthalene	8	8	0	0	0	NA	NA	100
Nitrobenzene	8	8	0	0	0	NA	NA	100
Pentachlorophenol	8	8	0	0	0	NA	NA	100
Phenanthrene	8	0	8	8	0	100	0	100
Phenol	8	8	0	0	0	NA	NA	100
Pyrene	8	0	8	4	4	50	50	50
All Results[2]	512	345	167	154	13	92	8	97
Pesticides								
4,4'-DDD	8	1	7	7	0	100	0	100
4,4'-DDE	8	1	7	7	0	100	0	100
4,4'-DDT	8	6	2	1	1	50	50	88
Aldrin	8	5	3	3	0	100	0	100
Alpha-BHC	8	3	5	5	0	100	0	100
Alpha-Chlordane	8	3	5	5	0	100	0	100
Beta-BHC	8	8	0	0	0	NA	NA	100

Table 4-13
Summary of Field Duplicate Results

Analyte	Total Number of Field Duplicate Pairs	Total Number of Field Duplicate Pairs with Non-Detects for Both Samples	Total Number of Field Duplicate Pairs with Positives in Either Sample					Overall Percent of Samples that Met the Criteria
			Total Number of Samples	Number of Samples that Met the Criteria[1]	Number of Samples that Did Not Meet the Criteria	Percent of Samples that Met the Criteria	Percent of Samples that Did Not Meet the Criteria	
Delta-BHC	8	6	2	2	0	100	0	100
Dieldrin	8	0	8	8	0	100	0	100
Endosulfan I	8	5	3	3	0	100	0	100
Endosulfan II	8	5	3	3	0	100	0	100
Endosulfan Sulfate	8	8	0	0	0	NA	NA	100
Endrin	8	2	6	6	0	100	0	100
Endrin Aldehyde	8	0	8	8	0	100	0	100
Endrin Ketone	8	7	1	1	0	100	0	100
Gamma-BHC (Lindane)	8	7	1	1	0	100	0	100
Gamma-Chlordane	8	3	5	5	0	100	0	100
Heptachlor	8	7	1	1	0	100	0	100
Heptachlor Epoxide	8	5	3	3	0	100	0	100
Methoxychlor	8	8	0	0	0	NA	NA	100
Toxaphene	8	8	0	0	0	NA	NA	100
All Results[2]	168	98	70	69	1	99	1	99
Aroclor PCBs								
Aroclor-1016	8	8	0	0	0	NA	NA	100
Aroclor-1221	8	8	0	0	0	NA	NA	100
Aroclor-1232	8	8	0	0	0	NA	NA	100
Aroclor-1242	8	7	1	1	0	100	0	100
Aroclor-1248	8	5	3	3	0	100	0	100
Aroclor-1254	8	6	2	2	0	100	0	100
Aroclor-1260	8	7	1	1	0	100	0	100
Aroclor-1262	8	8	0	0	0	NA	NA	100
Aroclor-1268	8	8	0	0	0	NA	NA	100
All Results[1]	72	65	7	7	0	100	NA	100
Herbicides								
2,4,5-T	8	8	0	0	0	NA	NA	100
2,4,5-TP	8	8	0	0	0	NA	NA	100
2,4-D	8	8	0	0	0	NA	NA	100
2,4-DB	8	8	0	0	0	NA	NA	100
All Results[2]	32	32	0	0	0	NA	NA	100
Dioxins/Furans								
1,2,3,4,6,7,8-HpCDD	8	0	8	5	3	63	38	63
1,2,3,4,6,7,8-HpCDF	8	0	8	3	5	38	63	38
1,2,3,4,7,8,9-HpCDF	8	0	8	5	3	63	38	63

Table 4-13
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			Total Number of Samples	Number of Samples that Met the Criteria[1]	Number of Samples that Did Not Meet the Criteria	Percent of Samples that Met the Criteria	Percent of Samples that Did Not Meet the Criteria	
1,2,3,4,7,8-HxCDD	8	0	8	8	0	100	0	100
1,2,3,4,7,8-HxCDF	8	0	8	3	5	38	63	38
1,2,3,6,7,8-HxCDD	8	0	8	8	0	100	0	100
1,2,3,6,7,8-HxCDF	8	0	8	5	3	63	38	63
1,2,3,7,8,9-HxCDD	8	0	8	8	0	100	0	100
1,2,3,7,8,9-HxCDF	8	0	8	6	2	75	25	75
1,2,3,7,8-PeCDD	8	0	8	8	0	100	0	100
1,2,3,7,8-PeCDF	8	0	8	8	0	100	0	100
2,3,4,6,7,8-HxCDF	8	0	8	6	2	75	25	75
2,3,4,7,8-PeCDF	8	0	8	5	3	63	38	63
2,3,7,8-TCDD	8	0	8	5	3	63	38	63
2,3,7,8-TCDF	8	0	8	8	0	100	0	100
OCDD	8	0	8	6	2	75	25	75
OCDF	8	0	8	2	6	25	75	25
Total HpCDD	8	0	8	4	4	50	50	50
Total HpCDF	8	0	8	3	5	38	63	38
Total HxCDD	8	0	8	3	5	38	63	38
Total HxCDF	8	0	8	3	5	38	63	38
Total PeCDD	8	0	8	5	3	63	38	63
Total PeCDF	8	0	8	3	5	38	63	38
Total TCDD	8	0	8	5	3	63	38	63
Total TCDF	8	0	8	5	3	63	38	63
All Results[2]	200	0	200	130	70	65	35	65
Congener PCBs								
PCB-1	8	0	8	3	5	38	63	38
PCB-100	8	0	8	6	2	75	25	75
PCB-103	8	0	8	6	2	75	25	75
PCB-104	8	3	5	5	0	100	0	100
PCB-105	8	0	8	4	4	50	50	50
PCB-106/118	8	0	8	5	3	63	38	63
PCB-107/109	8	0	8	5	3	63	38	63
PCB-108/112	8	0	8	5	3	63	38	63
PCB-11	8	0	8	6	2	75	25	75
PCB-110	8	0	8	5	3	63	38	63
PCB-111/115	8	0	8	5	3	63	38	63
PCB-113	8	0	8	5	3	63	38	63
PCB-114	8	0	8	6	2	75	25	75

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			Total Number of Samples	Number of Samples that Met the Criteria[1]	Number of Samples that Did Not Meet the Criteria	Percent of Samples that Met the Criteria	Percent of Samples that Did Not Meet the Criteria	
PCB-119	8	0	8	5	3	63	38	63
PCB-12/13	8	0	8	6	2	75	25	75
PCB-120	8	0	8	8	0	100	0	100
PCB-121	8	8	0	0	0	NA	NA	100
PCB-122	8	0	8	5	3	63	38	63
PCB-123	8	0	8	6	2	75	25	75
PCB-124	8	0	8	5	3	63	38	63
PCB-126	8	0	8	8	0	100	0	100
PCB-127	8	5	3	3	0	100	0	100
PCB-128/162	8	0	8	5	3	63	38	63
PCB-129	8	0	8	5	3	63	38	63
PCB-130	8	0	8	4	4	50	50	50
PCB-131	8	4	4	4	0	100	0	100
PCB-132/161	8	0	8	5	3	63	38	63
PCB-133/142	8	0	8	6	2	75	25	75
PCB-134/143	8	0	8	5	3	63	38	63
PCB-135	8	0	8	5	3	63	38	63
PCB-136	8	0	8	5	3	63	38	63
PCB-137	8	0	8	6	2	75	25	75
PCB-138/163/164	8	0	8	6	2	75	25	75
PCB-139/149	8	0	8	5	3	63	38	63
PCB-14	8	6	2	2	0	100	0	100
PCB-140	8	0	8	7	1	88	13	88
PCB-141	8	0	8	6	2	75	25	75
PCB-144	8	0	8	5	3	63	38	63
PCB-145	8	7	1	1	0	100	0	100
PCB-146/165	8	0	8	6	2	75	25	75
PCB-147	8	0	8	7	1	88	13	88
PCB-148	8	0	8	8	0	100	0	100
PCB-15	8	0	8	5	3	63	38	63
PCB-150	8	0	8	8	0	100	0	100
PCB-151	8	0	8	5	3	63	38	63
PCB-152	8	2	6	6	0	100	0	100
PCB-153	8	0	8	6	2	75	25	75
PCB-154	8	0	8	7	1	88	13	88
PCB-155	8	0	8	8	0	100	0	100
PCB-156	8	0	8	6	2	75	25	75

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			Total Number of Samples	Number of Samples that Met the Criteria[1]	Number of Samples that Did Not Meet the Criteria	Percent of Samples that Met the Criteria	Percent of Samples that Did Not Meet the Criteria	
PCB-157	8	0	8	7	1	88	13	88
PCB-158/160	8	0	8	5	3	63	38	63
PCB-159	8	0	8	4	4	50	50	50
PCB-16/32	8	0	8	4	4	50	50	50
PCB-166	8	0	8	8	0	100	0	100
PCB-167	8	0	8	6	2	75	25	75
PCB-168	8	0	8	8	0	100	0	100
PCB-169	8	7	1	1	0	100	0	100
PCB-17	8	0	8	4	4	50	50	50
PCB-170	8	0	8	6	2	75	25	75
PCB-171	8	0	8	6	2	75	25	75
PCB-172	8	0	8	6	2	75	25	75
PCB-173	8	0	8	8	0	100	0	100
PCB-174	8	0	8	6	2	75	25	75
PCB-175	8	0	8	6	2	75	25	75
PCB-176	8	0	8	6	2	75	25	75
PCB-177	8	0	8	6	2	75	25	75
PCB-178	8	0	8	6	2	75	25	75
PCB-179	8	0	8	6	2	75	25	75
PCB-18	8	0	8	3	5	38	63	38
PCB-180	8	0	8	6	2	75	25	75
PCB-181	8	1	7	6	1	86	14	88
PCB-182/187	8	0	8	6	2	75	25	75
PCB-183	8	0	8	6	2	75	25	75
PCB-184	8	2	6	6	0	100	0	100
PCB-185	8	0	8	6	2	75	25	75
PCB-186	8	6	2	2	0	100	0	100
PCB-188	8	2	6	6	0	100	0	100
PCB-189	8	0	8	8	0	100	0	100
PCB-19	8	0	8	4	4	50	50	50
PCB-190	8	0	8	6	2	75	25	75
PCB-191	8	0	8	7	1	88	13	88
PCB-192	8	4	4	4	0	100	0	100
PCB-193	8	0	8	6	2	75	25	75
PCB-194	8	0	8	6	2	75	25	75
PCB-195	8	0	8	6	2	75	25	75
PCB-196/203	8	0	8	6	2	75	25	75

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			Total Number of Samples	Number of Samples that Met the Criteria[1]	Number of Samples that Did Not Meet the Criteria	Percent of Samples that Met the Criteria	Percent of Samples that Did Not Meet the Criteria	
PCB-197	8	0	8	8	0	100	0	100
PCB-198	8	0	8	7	1	88	13	88
PCB-199	8	0	8	6	2	75	25	75
PCB-2	8	0	8	3	5	38	63	38
PCB-20/21/33	8	0	8	4	4	50	50	50
PCB-200	8	0	8	6	2	75	25	75
PCB-201	8	0	8	6	2	75	25	75
PCB-202	8	0	8	6	2	75	25	75
PCB-204	8	4	4	4	0	100	0	100
PCB-205	8	0	8	7	1	88	13	88
PCB-206	8	0	8	7	1	88	13	88
PCB-207	8	0	8	6	2	75	25	75
PCB-208	8	0	8	6	2	75	25	75
PCB-209	8	0	8	6	2	75	25	75
PCB-22	8	0	8	4	4	50	50	50
PCB-23	8	0	8	7	1	88	13	88
PCB-24/27	8	0	8	5	3	63	38	63
PCB-25	8	0	8	5	3	63	38	63
PCB-26	8	0	8	5	3	63	38	63
PCB-28	8	0	8	5	3	63	38	63
PCB-29	8	0	8	7	1	88	13	88
PCB-3	8	0	8	3	5	38	63	38
PCB-30	8	3	5	5	0	100	0	100
PCB-31	8	0	8	5	3	63	38	63
PCB-34	8	0	8	6	2	75	25	75
PCB-35	8	0	8	3	5	38	63	38
PCB-36	8	0	8	8	0	100	0	100
PCB-37	8	0	8	5	3	63	38	63
PCB-38	8	0	8	7	1	88	13	88
PCB-39	8	0	8	8	0	100	0	100
PCB-4/10	8	0	8	2	6	25	75	25
PCB-40	8	0	8	4	4	50	50	50
PCB-41/64/71/72	8	0	8	4	4	50	50	50
PCB-42/59	8	0	8	4	4	50	50	50
PCB-43/49	8	0	8	4	4	50	50	50
PCB-44	8	0	8	4	4	50	50	50
PCB-45	8	0	8	4	4	50	50	50

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Summary of Field Duplicate Results

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			Total Number of Samples	Number of Samples that Met the Criteria[1]	Number of Samples that Did Not Meet the Criteria	Percent of Samples that Met the Criteria	Percent of Samples that Did Not Meet the Criteria	
PCB-46	8	0	8	4	4	50	50	50
PCB-47	8	0	8	5	3	63	38	63
PCB-48/75	8	0	8	4	4	50	50	50
PCB-5/8	8	0	8	4	4	50	50	50
PCB-50	8	0	8	6	2	75	25	75
PCB-51	8	0	8	5	3	63	38	63
PCB-52/69	8	0	8	4	4	50	50	50
PCB-53	8	0	8	4	4	50	50	50
PCB-54	8	0	8	6	2	75	25	75
PCB-55	8	0	8	5	3	63	38	63
PCB-56/60	8	0	8	4	4	50	50	50
PCB-57	8	0	8	5	3	63	38	63
PCB-58	8	0	8	8	0	100	0	100
PCB-6	8	0	8	3	5	38	63	38
PCB-61/70	8	0	8	4	4	50	50	50
PCB-62	8	2	6	6	0	100	0	100
PCB-63	8	0	8	4	4	50	50	50
PCB-65	8	1	7	6	1	86	14	88
PCB-67	8	0	8	4	4	50	50	50
PCB-68	8	0	8	6	2	75	25	75
PCB-7/9	8	0	8	3	5	38	63	38
PCB-73	8	6	2	0	2	0	100	75
PCB-74	8	0	8	3	5	38	63	38
PCB-76/66	8	0	8	4	4	50	50	50
PCB-77	8	0	8	4	4	50	50	50
PCB-78	8	1	7	5	2	71	29	75
PCB-79	8	0	8	8	0	100	0	100
PCB-80	8	7	1	1	0	100	0	100
PCB-81	8	0	8	5	3	63	38	63
PCB-82	8	0	8	4	4	50	50	50
PCB-83	8	1	7	7	0	100	0	100
PCB-84/92	8	0	8	5	3	63	38	63
PCB-85/116	8	0	8	5	3	63	38	63
PCB-86	8	0	8	6	2	75	25	75
PCB-87/117/125	8	0	8	5	3	63	38	63
PCB-88/91	8	0	8	5	3	63	38	63
PCB-89	8	0	8	4	4	50	50	50

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			Total Number of Samples	Number of Samples that Met the Criteria[1]	Number of Samples that Did Not Meet the Criteria	Percent of Samples that Met the Criteria	Percent of Samples that Did Not Meet the Criteria	
PCB-90/101	8	0	8	5	3	63	38	63
PCB-93	8	8	0	0	0	NA	NA	100
PCB-94	8	0	8	5	3	63	38	63
PCB-95/98/102	8	0	8	5	3	63	38	63
PCB-96	8	0	8	6	2	75	25	75
PCB-97	8	0	8	5	3	63	38	63
PCB-99	8	0	8	5	3	63	38	63
Total decaCB	8	0	8	6	2	75	25	75
Total diCB	8	0	8	5	3	63	38	63
Total heptaCB	8	0	8	6	2	75	25	75
Total hexaCB	8	0	8	5	3	63	38	63
Total monoCB	8	0	8	3	5	38	63	38
Total nonaCB	8	0	8	6	2	75	25	75
Total octaCB	8	0	8	6	2	75	25	75
Total PCB	8	0	8	5	3	63	38	63
Total pentaCB	8	0	8	5	3	63	38	63
Total tetraCB	8	0	8	4	4	50	50	50
Total triCB	8	0	8	5	3	63	38	63
All Results[2]	1432	90	1342	929	413	69	31	71
Inorganics								
Aluminum	8	0	8	7	1	88	13	88
Antimony	8	5	3	3	0	100	0	100
Arsenic	8	0	8	7	1	88	13	88
Barium	8	0	8	7	1	88	13	88
Beryllium	8	6	2	2	0	100	0	100
Cadmium	8	5	3	3	0	100	0	100
Calcium	8	0	8	5	3	63	38	63
Chromium	8	0	8	5	3	63	38	63
Cobalt	8	0	8	8	0	100	0	100
Copper	8	0	8	6	2	75	25	75
Cyanide	8	6	2	2	0	100	0	100
Hexavalent Chromium	8	2	6	6	0	100	0	100
Iron	8	0	8	7	1	88	13	88
Lead	8	0	8	5	3	63	38	63
Magnesium	8	0	8	8	0	100	0	100
Manganese	8	0	8	8	0	100	0	100
Mercury	8	0	8	7	1	88	13	88

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			Total Number of Samples	Number of Samples that Met the Criteria[1]	Number of Samples that Did Not Meet the Criteria	Percent of Samples that Met the Criteria	Percent of Samples that Did Not Meet the Criteria	
Nickel	8	0	8	7	1	88	13	88
Potassium	8	0	8	8	0	100	0	100
Selenium	8	2	6	5	1	83	17	88
Silver	8	4	4	4	0	100	0	100
Sodium	8	0	8	8	0	100	0	100
Thallium	8	8	0	0	0	NA	NA	100
Vanadium	8	0	8	8	0	100	0	100
Zinc	8	1	7	5	2	71	29	75
All Results[2]	200	39	161	141	20	88	12	90
AVS/SEM								
Acid Volatile Sulfide	8	5	3	1	2	33	67	75
Cadmium	8	0	8	8	0	100	0	100
Copper	8	0	8	5	3	63	38	63
Lead	8	0	8	7	1	88	13	88
Mercury	8	6	2	2	0	100	0	100
Nickel	8	0	8	7	1	88	13	88
Silver	8	4	4	4	0	100	0	100
Zinc	8	0	8	7	1	88	13	88
All Results[2]	56	10	46	40	6	87	13	89
Miscellaneous								
pH	8	0	8	8	0	100	0	100
ORP	8	0	8	6	2	75	25	75
TOC	8	0	8	6	2	75	25	75
TEPH	8	0	8	6	2	75	25	75
Grain Size								
0.001 mm	8	2	6	5	1	83	17	88
0.002 mm	8	1	7	7	0	100	0	100
0.005 mm	8	1	7	6	1	86	14	88
0.02 mm	8	0	8	8	0	100	0	100
0.05 mm	8	0	8	8	0	100	0	100
0.064 mm	8	0	8	8	0	100	0	100
0.075 mm	8	0	8	8	0	100	0	100
0.15 mm	8	0	8	8	0	100	0	100
0.3 mm	8	0	8	8	0	100	0	100
0.6 mm	8	0	8	8	0	100	0	100
1.18 mm	8	0	8	8	0	100	0	100

Table 4-13
Summary of Field Duplicate Results

Analyte	Total Number of Field Duplicate Pairs	Total Number of Field Duplicate Pairs with Non-Detects for Both Samples	Total Number of Field Duplicate Pairs with Positives in Either Sample					Overall Percent of Samples that Met the Criteria
			Total Number of Samples	Number of Samples that Met the Criteria[1]	Number of Samples that Did Not Meet the Criteria	Percent of Samples that Met the Criteria	Percent of Samples that Did Not Meet the Criteria	
19 mm	8	0	8	8	0	100	0	100
2.36 mm	8	0	8	8	0	100	0	100
3.35 mm	8	0	8	8	0	100	0	100
37.5 mm	8	0	8	8	0	100	0	100
4.75 mm	8	0	8	8	0	100	0	100
75 mm	8	0	8	8	0	100	0	100
All Results[2]	136	4	132	130	2	98	2	99
Radiochemistry								
Pb-210	3	0	3	3	0	100	0	100
Be-7	1	0	1	1	0	100	0	100
Cs-137	3	3	0	0	0	NA	NA	100
All Results[2]	7	3	4	4	0	100	NA	100

Notes:
[1] VOCs - Volatile Organic Compounds
[2] SVOCs - Semivolatile Organic Compounds
[3] PCBs - Polychlorinated Biphenyls
[4] AVS/SEM - Acid Volatile Sulfide/Simultaneous Extractable Metals
[5] ORP - Oxidation Reduction Potential
[6] TOC - Total Organic Carbon
[7] TEPH - Total Extractable Petroleum Hydrocarbons

[1] For field duplicate pairs where both results were greater than or equal to five times the reporting limit, the relative percent difference (RPD) between the results had to be less than 40%. For field duplicate pairs where at least one result was less than five-times the reporting limit (including when one result was a not-detect), the difference between the results had to be less than two-times the reporting limit.
[2] All Results - Total number of Field Duplicate pairs multiplied by the number of analytes determined by the method.

Table 4-14
Summary Statistics for Equipment Blanks

Analyte	Method	Number of Equipment Blanks	Equipment Blanks with Results > MDL	Minimum Concentration	Maximum Concentration	Average Concentration	Median Concentration	Concentration Units	Percent Contaminated
VOCs									
Methylene Chloride	8260B	9	1	0.86	0.86	0.86	0.86	ug/L	11%
Dioxin/Furans									
OCDD	EPA Method 1613	9	5	3.13	4.31	3.51	3.38	pg/L	56%
OCDF	EPA Method 1613	9	2	1.39	2.1	1.75	1.75	pg/L	22%
Total HpCDD	EPA Method 1613	9	2	0.865	1.2	1.03	1.03	pg/L	22%
Total PeCDD	EPA Method 1613	9	1	2.06	2.06	2.06	2.06	pg/L	11%
Total TCDF	EPA Method 1613	9	4	1.54	2.09	1.90	1.98	pg/L	44%
Congener PCBs									
PCB-1	EPA Method 1668	9	6	25.9	37.8	31.7	31.1	pg/L	67%
PCB-106/118	EPA Method 1668	9	1	31.7	31.7	31.7	31.7	pg/L	11%
PCB-11	EPA Method 1668	9	1	65.3	65.3	65.3	65.3	pg/L	11%
PCB-110	EPA Method 1668	9	1	46.8	46.8	46.8	46.8	pg/L	11%
PCB-138/163/164	EPA Method 1668	9	2	29	35.7	32.4	32.4	pg/L	22%
PCB-139/149	EPA Method 1668	9	1	33.3	33.3	33.3	33.3	pg/L	11%
PCB-153	EPA Method 1668	9	2	27.4	35.9	31.7	31.7	pg/L	22%
PCB-16/32	EPA Method 1668	9	1	27.4	27.4	27.4	27.4	pg/L	11%
PCB-18	EPA Method 1668	9	5	32	53.9	41.2	40.3	pg/L	56%
PCB-180	EPA Method 1668	9	1	42.8	42.8	42.8	42.8	pg/L	11%
PCB-209	EPA Method 1668	9	1	190	190	190	190	pg/L	11%
PCB-28	EPA Method 1668	9	2	31.9	33.4	32.7	32.7	pg/L	22%
PCB-31	EPA Method 1668	9	2	29	46.7	37.9	37.9	pg/L	22%
PCB-37	EPA Method 1668	9	1	70.3	70.3	70.3	70.3	pg/L	11%
PCB-41/64/71/72	EPA Method 1668	9	2	36.3	40	38.2	38.2	pg/L	22%
PCB-43/49	EPA Method 1668	9	2	29.8	34.6	32.2	32.2	pg/L	22%
PCB-44	EPA Method 1668	9	2	34.8	47.7	41.3	41.3	pg/L	22%
PCB-52/69	EPA Method 1668	9	5	26.6	65.8	41	39.7	pg/L	56%
PCB-61/70	EPA Method 1668	9	1	46.9	46.9	46.9	46.9	pg/L	11%
PCB-76/66	EPA Method 1668	9	1	39.4	39.4	39.4	39.4	pg/L	11%
PCB-85/116	EPA Method 1668	9	1	28.1	28.1	28.1	28.1	pg/L	11%
PCB-90/101	EPA Method 1668	9	1	40.6	40.6	40.6	40.6	pg/L	11%
PCB-95/98/102	EPA Method 1668	9	2	29.4	30.7	30.1	30.1	pg/L	22%
Total decaCB	EPA Method 1668	9	1	190	190	190	190	pg/L	11%
Total diCB	EPA Method 1668	9	1	65.3	65.3	65.3	65.3	pg/L	11%
Total heptaCB	EPA Method 1668	9	1	42.8	42.8	42.8	42.8	pg/L	11%
Total hexaCB	EPA Method 1668	9	2	56.3	105	80.7	80.7	pg/L	22%
Total monoCB	EPA Method 1668	9	6	25.9	37.8	31.7	31.1	pg/L	67%
Total PCB	EPA Method 1668	9	8	25.9	939	227	130	pg/L	89%
Total pentaCB	EPA Method 1668	9	2	29.4	178	104	104	pg/L	22%
Total tetraCB	EPA Method 1668	9	5	26.6	274	103	39.7	pg/L	56%
Total triCB	EPA Method 1668	9	5	32	203	88.9	40.3	pg/L	56%

Table 4-14
Summary Statistics for Equipment Blanks

Analyte	Method	Number of Equipment Blanks	Equipment Blanks with Results > MDL	Minimum Concentration	Maximum Concentration	Average Concentration	Median Concentration	Concentration Units	Percent Contaminated
Inorganics									
Aluminum	6010B	9	9	9.1	81.9	34.5	22.8	ug/L	100%
Beryllium	6010B	9	8	0.59	1.7	1.37	1.55	ug/L	89%
Cadmium	6010B	9	1	1.8	1.8	1.8	1.8	ug/L	11%
Calcium	6010B	9	4	52.2	179	112	109	ug/L	44%
Chromium	6010B	9	5	1.3	8.8	2.94	1.6	ug/L	56%
Copper	6010B	9	1	2.8	2.8	2.8	2.8	ug/L	11%
Cyanide	9012A	9	1	56.2	56.2	56.2	56.2	ug/L	11%
Iron	6010B	9	5	19.5	299	93.9	27.1	ug/L	56%
Magnesium	6010B	9	3	10.9	19	13.7	11.2	ug/L	33%
Manganese	6010B	9	7	0.19	3.9	1.64	1.1	ug/L	78%
Nickel	6010B	9	5	1.2	5.5	2.5	2	ug/L	56%
Potassium	6010B	9	9	106	210	123	114	ug/L	100%
Silver	6010B	9	2	0.31	0.31	0.31	0.31	ug/L	22%
Thallium	6010B	9	1	6.6	6.6	6.6	6.6	ug/L	11%
Zinc	6010B	9	9	3.8	26.6	10.3	5.6	ug/L	100%

Notes:
1. Equipment blank contamination was not observed for the fractions not identified.
2. VOCs - Volatile Organic Compounds
3. PCBs - Polychlorinated Biphenyls
4. ug/L - micrograms per liter
5. pg/L - picograms per liter

Table 4-15
Summary Statistics for Equipment Blanks

Analyte	Method	Number of Equipment Blanks	Equipment Blanks with Results > MDL	Minimum Concentration	Maximum Concentration	Average Concentration	Median Concentration	Concentration Units	Percent Contaminated
VOCs									
Methylene Chloride	8260B	9	1	0.86	0.86	0.86	0.86	ug/L	11%
Dioxin/Furans									
OCDD	EPA Method 1613	9	5	3.13	4.31	3.51	3.38	pg/L	56%
OCDF	EPA Method 1613	9	2	1.39	2.1	1.75	1.75	pg/L	22%
Total HpCDD	EPA Method 1613	9	2	0.865	1.2	1.03	1.03	pg/L	22%
Total PeCDD	EPA Method 1613	9	1	2.06	2.06	2.06	2.06	pg/L	11%
Total TCDF	EPA Method 1613	9	4	1.54	2.09	1.90	1.98	pg/L	44%
Congener PCBs									
PCB-1	EPA Method 1668	9	6	25.9	37.8	31.7	31.1	pg/L	67%
PCB-106/118	EPA Method 1668	9	1	31.7	31.7	31.7	31.7	pg/L	11%
PCB-11	EPA Method 1668	9	1	65.3	65.3	65.3	65.3	pg/L	11%
PCB-110	EPA Method 1668	9	1	46.8	46.8	46.8	46.8	pg/L	11%
PCB-138/163/164	EPA Method 1668	9	2	29	35.7	32.4	32.4	pg/L	22%
PCB-139/149	EPA Method 1668	9	1	33.3	33.3	33.3	33.3	pg/L	11%
PCB-153	EPA Method 1668	9	2	27.4	35.9	31.7	31.7	pg/L	22%
PCB-16/32	EPA Method 1668	9	1	27.4	27.4	27.4	27.4	pg/L	11%
PCB-18	EPA Method 1668	9	5	32	53.9	41.2	40.3	pg/L	56%
PCB-180	EPA Method 1668	9	1	42.8	42.8	42.8	42.8	pg/L	11%
PCB-209	EPA Method 1668	9	1	190	190	190	190	pg/L	11%
PCB-28	EPA Method 1668	9	2	31.9	33.4	32.7	32.7	pg/L	22%
PCB-31	EPA Method 1668	9	2	29	46.7	37.9	37.9	pg/L	22%
PCB-37	EPA Method 1668	9	1	70.3	70.3	70.3	70.3	pg/L	11%
PCB-41/64/71/72	EPA Method 1668	9	2	36.3	40	38.2	38.2	pg/L	22%
PCB-43/49	EPA Method 1668	9	2	29.8	34.6	32.2	32.2	pg/L	22%
PCB-44	EPA Method 1668	9	2	34.8	47.7	41.3	41.3	pg/L	22%
PCB-52/69	EPA Method 1668	9	5	26.6	65.8	41	39.7	pg/L	56%
PCB-61/70	EPA Method 1668	9	1	46.9	46.9	46.9	46.9	pg/L	11%
PCB-76/66	EPA Method 1668	9	1	39.4	39.4	39.4	39.4	pg/L	11%
PCB-85/116	EPA Method 1668	9	1	28.1	28.1	28.1	28.1	pg/L	11%
PCB-90/101	EPA Method 1668	9	1	40.6	40.6	40.6	40.6	pg/L	11%
PCB-95/98/102	EPA Method 1668	9	2	29.4	30.7	30.1	30.1	pg/L	22%
Total decaCB	EPA Method 1668	9	1	190	190	190	190	pg/L	11%
Total diCB	EPA Method 1668	9	1	65.3	65.3	65.3	65.3	pg/L	11%
Total heptaCB	EPA Method 1668	9	1	42.8	42.8	42.8	42.8	pg/L	11%
Total hexaCB	EPA Method 1668	9	2	56.3	105	80.7	80.7	pg/L	22%
Total monoCB	EPA Method 1668	9	6	25.9	37.8	31.7	31.1	pg/L	67%
Total PCB	EPA Method 1668	9	8	25.9	939	227	130	pg/L	89%
Total pentaCB	EPA Method 1668	9	2	29.4	178	104	104	pg/L	22%
Total tetraCB	EPA Method 1668	9	5	26.6	274	103	39.7	pg/L	56%
Total triCB	EPA Method 1668	9	5	32	203	88.9	40.3	pg/L	56%

Table 4-15
Summary Statistics for Equipment Blanks

Analyte	Method	Number of Equipment Blanks	Equipment Blanks with Results > MDL	Minimum Concentration	Maximum Concentration	Average Concentration	Median Concentration	Concentration Units	Percent Contaminated
Inorganics									
Aluminum	6010B	9	9	9.1	81.9	34.5	22.8	ug/L	100%
Beryllium	6010B	9	8	0.59	1.7	1.37	1.55	ug/L	89%
Cadmium	6010B	9	1	1.8	1.8	1.8	1.8	ug/L	11%
Calcium	6010B	9	4	52.2	179	112	109	ug/L	44%
Chromium	6010B	9	5	1.3	8.8	2.94	1.6	ug/L	56%
Copper	6010B	9	1	2.8	2.8	2.8	2.8	ug/L	11%
Cyanide	9012A	9	1	56.2	56.2	56.2	56.2	ug/L	11%
Iron	6010B	9	5	19.5	299	93.9	27.1	ug/L	56%
Magnesium	6010B	9	3	10.9	19	13.7	11.2	ug/L	33%
Manganese	6010B	9	7	0.19	3.9	1.64	1.1	ug/L	78%
Nickel	6010B	9	5	1.2	5.5	2.5	2	ug/L	56%
Potassium	6010B	9	9	106	210	123	114	ug/L	100%
Silver	6010B	9	2	0.31	0.31	0.31	0.31	ug/L	22%
Thallium	6010B	9	1	6.6	6.6	6.6	6.6	ug/L	11%
Zinc	6010B	9	9	3.8	26.6	10.3	5.6	ug/L	100%

Notes:
1. Equipment blank contamination was not observed for the fractions not identified.
2. VOCs - Volatile Organic Compounds
3. PCBs - Polychlorinated Biphenyls
4. ug/L - micrograms per liter
5. pg/L - picograms per liter

Table 5-1
Sample Collection Summary

Coring Location	Longitudinal Orientation	Lateral Orientation	Sampling Depth Interval (feet)						
			0-0.5	0.5-2	2-4	4-6	6-8	8-10	10-12
HRRISED003	Transect 3	West	x	x	x				
HRRISED004		East	x	x					
HRRISED005	Transect 5	West	x	x	x	x	x	x	x
HRRISED006		East	x	x	x				
HRRISED007	Transect 7	West	x	x					
HRRISED008		East	x	x					
HRRISED009	Transect 9	West	x						
HRRISED010		East	x	x	x				
HRRISED011	Transect 11	West	x	x	x				
HRRISED012		East	x	x					
HRRISED013	Transect 13	West	x	x	x				
HRRISED014		West	x	x					
HRRISED015		East	x	x					
HRRISED016	Transect 15	West	x	x	x				
HRRISED017		West	x	x	x				
HRRISED018		East	x	x	x				
HRRISED019		East	x	x	x	x	x	x	x
HRRISED020		East	x	x	x				
HRRISED021	Transect 17	West	x	x					
HRRISED022		West	x	x					
HRRISED023		East	x	x	x				
HRRISED024		East	x	x	x				
HRRISED025		East	x	x	x				
HRRISED026	Transect 19	West	x	x					
HRRISED027		East	x	x	x				
HRRISED028		East	x	x	x				
HRRISED029	Transect 21	West	x	x					
HRRISED030		East	x	x	x				
HRRISED001	Transect 22	West	x	x					
HRRISED002		East	x	x					
HRRISED031	Transect 23	West	x	x					
HRRISED032		East	x	x	x				
HRRISED037	Transect 24	West	x	x					
HRRISED038		East	x	x					
HRRISED034	Transect 25	East	x	x	x				
HRRISED035	Transect 27	West	x	x					
HRRISED036		East	x	x	x	x	x	x	x

Table 5-1
Sample Collection Summary

Coring Location	Longitudinal Orientation	Lateral Orientation	Sampling Depth Interval (feet)						
			0-0.5	0.5-2	2-4	4-6	6-8	8-10	10-12
HRRISED042	Mudflat 1	East	x						
HRRISED043		East	x						
HRRISED044		East	x						
HRRISED039	Mudflat 2	West	x						
HRRISED040		West	x						
HRRISED041		West	x						
HRRISED045	Mudflat 4	East	x						
HRRISED046		East	x						
HRRISED047		East	x						
HRRISED048	Mudflat 6	West	x						
HRRISED049		West	x						
HRRISED050		West	x						
HRRISED051	Mudflat 9	East	x						
HRRISED052		East	x						
HRRISED053		East	x						
HRRISED054	Mudflat 10	East	x						
HRRISED055		East	x						
HRRISED056		East	x						
HRRISED057		East	x						

Notes:

1. See Figure 3-1 for actual sampling locations.

Table 5-2
Comparison of Sediment Data Previously Collected by the PRG and 2006 Remedial Investigation Data

Analyte	Units	Data Previously Collected by the PRG			2006 Remedial Investigation Data	
		Arithmetic Mean of Detects	Range of Detects	Data Source	Arithmetic Mean of Detects	Range of Detects
VOCs						
Benzene	ug/kg	1,150	14 - 4,580	a, b, c, d, e	287	3.3 - 1,800
Ethylbenzene	ug/kg	5,890	3 - 33,600	a, b, d, e	1,630	3.8 - 8,600
Toluene	ug/kg	126	3 - 375	a, b, c, d, e	97	0.89 - 1,400
Xylenes	ug/kg	1,590	2 - 5,100	a, b, e	1,680	13 - 12,000
SVOCs						
1,2,4-Trichlorobenzene	ug/kg	51,700	67 - 930,000	a, c, d, e	756	23 - 5,600
1,2-Dichlorobenzene	ug/kg	108,000	90 - 2,000,000	a, c, d, e	76	10 - 640
1,3-Dichlorobenzene	ug/kg	27,200	46 - 430,000	a, c, d, e	239	7.7 - 2,700
1,4-Dichlorobenzene	ug/kg	42,900	86 - 1,000,000	a, c, d, e	483	9.4 - 8,500
Naphthalene	ug/kg	125,000	33.5 - 4,570,000	a, b, c, d, e	216,000	14 - 11,000,000
Total PAHs	ug/kg	239,000	33.5 - 4,580,000	a, b, c, d, e	1,570,000	13 - 75,300,000
INORGANICS						
Total Chromium	mg/kg	1,630	6.59 - 14400	a, c, d, e	95	5.5 - 1,170
Hexavalent Chromium	mg/kg	8.01	0.74 - 73.1	a, c, e	2.37	0.34 - 19.7
Lead	mg/kg	105	2.73 - 437	a, c, d, e	89.8	0.045 - 709
Mercury	mg/kg	1.46	0.031 - 6.5	a, c, d, e	1.74	0.0000475 - 21.5
Total Cyanide	mg/kg	3.41	1.155 - 8.4	a	2.23	0.33 - 8.3
PCBs/PESTICIDES						
Total Aroclor PCBs	ug/kg	140	30 - 430	a, d, e	914	30 - 8,000
Total DDT	ug/kg	15.2	2 - 46	a, d, e	139	0.57 - 5,600
DIOXINS/FURANS						
2,3,7,8-TCDD	pg/g	58.4	7.86 - 96.1	c, d	82.9	0.113 - 2,990

Notes:
1. PRG - Peninsula Restoration Group
2. 2,3,7,8-TCDD - 2,3,7,8-Tetrachlorodibenzo-p-dioxin
3. PAH - Polyaromatic Hydrocarbon
4. PCB - Polychlorinated Biphenyl
5. SVOC - Semi-Volatile Organic Compound
6. VOC - Volatile Organic Compound
7. mg/kg - milligrams per kilogram
8. pg/g - picograms per gram
9. ug/kg - micrograms per kilogram
10. Statistics were calculated using detected values only.
11. Field and duplicate sample results were averaged together to create one result.

Data Sources for Data Previously Collected by the PRG:
[a] 1991-1993 Diamond Site Remedial Investigation
[b] 1996-1997 SCCC Site Focused Remedial Investigation
[c] 2000 SCCC Site Remedial Investigation
[d] 2002 SCCC SSL Superfund Contract Support Team Sampling
[e] 2004 Diamond Site Toxicity Study

Table 5-3
Non-COIs Detected at Frequencies Greater Than 75%

Analyte	Units	Frequency of Detects
Dioxins/Furans		
OCDD	pg/g	100%
Total HpCDD	pg/g	100%
Total HxCDD	pg/g	99%
1,2,3,4,6,7,8-HpCDD	pg/g	98%
Total PeCDD	pg/g	98%
Total TCDD	pg/g	98%
Total TCDF	pg/g	97%
Total HxCDF	pg/g	96%
Total PeCDF	pg/g	95%
1,2,3,6,7,8-HxCDD	pg/g	94%
1,2,3,7,8,9-HxCDD	pg/g	91%
1,2,3,4,7,8-HxCDD	pg/g	86%
1,2,3,7,8-PeCDD	pg/g	84%
Total HpCDF	pg/g	83%
1,2,3,4,6,7,8-HpCDF	pg/g	81%
1,2,3,4,7,8-HxCDF	pg/g	81%
OCDF	pg/g	81%
Inorganics		
Aluminum	mg/kg	100%
Arsenic	mg/kg	100%
Barium	mg/kg	100%
Calcium	mg/kg	100%
Cobalt	mg/kg	100%
Copper	mg/kg	100%
Iron	mg/kg	100%
Magnesium	mg/kg	100%
Manganese	mg/kg	100%
Nickel	mg/kg	100%
Potassium	mg/kg	100%
Sodium	mg/kg	100%
Vanadium	mg/kg	100%
Zinc	mg/kg	98%
Selenium	mg/kg	78%
Miscellaneous		
TEPH	mg/kg	98%
Total Organic Carbon	mg/kg	95%

Table 5-3
Non-COIs Detected at Frequencies Greater Than 75%

Analyte	Units	Frequency of Detects
PCB Congeners		
Total Homolog Groups	pg/g	100%
Total monoCB	pg/g	96%
PCB-2	pg/g	94%
Total tetraCB	pg/g	88%
PCB-3	pg/g	87%
Total pentaCB	pg/g	86%
PCB-90/101	pg/g	85%
PCB-52/69	pg/g	82%
PCB-61/70	pg/g	82%
Total hexaCB	pg/g	82%
PCB-106/118	pg/g	81%
PCB-28	pg/g	81%
PCB-43/49	pg/g	81%
PCB-110	pg/g	81%
PCB-31	pg/g	81%
PCB-41/64/71/72	pg/g	81%
Total triCB	pg/g	81%
PCB-138/163/164	pg/g	80%
PCB-76/66	pg/g	80%
PCB-56/60	pg/g	79%
PCB-153	pg/g	78%
PCB-44	pg/g	78%
PCB-95/98/102	pg/g	78%
Total heptaCB	pg/g	78%
PCB-139/149	pg/g	77%
Total diCB	pg/g	77%
PCB-15	pg/g	77%
PCB-16/32	pg/g	77%
PCB-74	pg/g	77%
PCB-47	pg/g	76%
PCB-84/92	pg/g	76%
PCB-99	pg/g	76%
PCB-20/21/33	pg/g	75%
PCB-22	pg/g	75%
PCB-37	pg/g	75%
PCB-42/59	pg/g	75%
SVOCs		
Fluoranthene	µg/kg	75%

TABLE 6-1
ENVIRONMENTALLY SENSITIVE AREAS ON OR ADJACENT TO THE HACKENSACK RIVER STUDY AREA

Environmentally Sensitive Areas Identified at N.J.A.C. 7:1E-1.8	Presence or Absence
1. Surface waters (rivers, creeks, streams, ponds, lakes, reservoirs)	Present - Hackensack River
2. Sources of water supply (surface water intakes or wells)	Absent
3. Bay islands and barrier island corridors	Absent
4. Beaches	Absent
5. Dunes	Absent
6. Wetland and wetland transition areas	Present - Wetland areas mapped by USFWS located within property boundaries
7. Breeding areas for forest area nesting species, colonial waterbirds, or aquatic furbearers	Present
8. Migratory stopover areas for migrant shorebirds, raptors, or passerines	Present
9. Wintering areas, including coastal tidal marshes and water areas, waterfowl concentration areas, and Atlantic White Cedar stands	Present
10. Prime fishing areas	Absent
11. Finfish migratory pathways	Present
12. Estuarine areas	Present
13. Water areas supporting submerged vegetation	Absent
14. Shellfish harvesting waters	Absent
15. Forest areas	Absent
16. Habitat for federal and state endangered or threatened plant and animal species	Present
17. Federal and state wilderness areas	Present - Hackensack Meadowlands
18. Areas designated wild, scenic, recreational, or developed recreational rivers	Absent

TABLE 6-2
NATIONAL WETLANDS INVENTORY (NWI) WETLANDS FOR THE HACKENSACK RIVER STUDY AREA

Wetland Type	NWI Code	Size (acres)	Cumulative Size (acres)
Estuarine & Marine Deepwater	E1UBLx	22	449
	E1UBLx	427	
Estuarine & Marine Wetland	E2EM5N	0.39	114
	E2EM5N	1.04	
	E2EM5N	0.065	
	E2EM5N6	1.93	
	E2EM5Pd	19.2	
	E2EM5Pd	55.1	
	E2EM5Pd	22.6	
	E2M5P	14	
Freshwater Emergent Wetland	PEM1Fh	0.77	29
	PEM5As	0.22	
	PEM5R	9.5	
	PEM5R	19	
Freshwater Pond	PUBHh	0.031	2.5
	PUBHx	0.78	
	PUBV	0.32	
	PUBVx	1.4	
Other	PUSRs	0.89	2.8
	PUSRs	0.89	
	PUSRs	0.97	

Notes:
1. Source - USFWS NWI Mapper

TABLE 6-3
SELECTION OF SEDIMENT SCREENING CRITERIA

Chemical	Primary Criteria		Secondary Criteria							Final	
	NJDEP Marine Guidelines		NJDEP Freshwater Guidelines		McDonald et al. Freshwater Guidelines		ORNL PRGs	Lowest Secondary Value		Selected Screening Value	
								Lower	Upper	Lower	Upper
	ER-L	ER-M	LEL	SEL	TEC	PEC	PRG	Effects	Effects	Effects	Effects
Inorganics (mg/kg)											
Aluminum	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	--	--	--	--
Arsenic	8.2	70	6	33	9.79	33	42	6	33	8.2	70
Barium	--	--	--	--	--	--	--	--	--	--	--
Beryllium	--	--	--	--	--	--	--	--	--	--	--
Cadmium	1.2	9.6	0.6	10	0.99	4.98	4.2	0.6	4.2	1.2	9.6
Chromium (Total)	81	370	26	110	43.4	111	159	26	110	81	370
Chromium (Hexavalent)	--	--	--	--	--	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--	--	--	--
Copper	34	270	16	110	31.6	149	77.7	16	77.7	34	270
Cyanide	--	--	--	--	--	--	--	--	--	--	--
Iron	--	--	--	--	--	--	--	--	--	--	--
Lead	47	218	31	250	35.8	128	110	31	110	47	218
Manganese	--	--	--	--	--	--	--	--	--	--	--
Mercury	0.15	0.71	0.2	2	0.18	1.06	0.7	0.18	0.7	0.15	0.71
Nickel	21	52	16	75	22.7	48.6	38.5	16	38.5	21	52
Selenium	--	--	--	--	--	--	--	--	--	--	--
Silver	1	3.7	1	--	--	--	1.8	1	1.8	1	3.7
Thallium	--	--	--	--	--	--	--	--	--	--	--
Tin	--	--	--	--	--	--	--	--	--	--	--
Vanadium	--	--	--	--	--	--	--	--	--	--	--
Zinc	150	410	120	820	121	459	270	120	270	150	410
Dioxins/Furans (pg/g)											
WHO Dioxin TEQ (Birds)	--	--	--	--	--	--	--	--	--	--	--
WHO Dioxin TEQ (Fish)	--	--	--	--	--	--	--	--	--	--	--
WHO Dioxin TEQ (Human/Mammal)	--	--	--	--	--	--	--	--	--	--	--
PCBs (pg/g)											
Total PCB	23,000	180,000	70,000	530,000,000	59,800	676,000	180,000	59,800	180,000	23,000	180,000
WHO PCB Congener TEQ (Birds)	--	--	--	--	--	--	--	--	--	--	--
WHO PCB Congener TEQ (Fish)	--	--	--	--	--	--	--	--	--	--	--
WHO PCB Congener TEQ (Human/Mammal)	--	--	--	--	--	--	--	--	--	--	--
Pesticides (µg/kg)											
4,4'-DDE	2.2	27	5	19,000	--	--	27	5	27	2.2	27
4,4'-DDD	--	--	8	6,000	--	--	7.8	8	7.8	8	7.8
4,4'-DDT	--	--	--	--	--	--	7.8	--	7.8	--	7.8
Total DDT	1.6	46	7	12,000	5.28	572	--	5.28	572	1.6	46
Aldrin	2	8,000	2	8,000	--	--	80	2	80	2	8,000

TABLE 6-3
SELECTION OF SEDIMENT SCREENING CRITERIA

Chemical	Primary Criteria		Secondary Criteria							Final	
	NJDEP Marine Guidelines		NJDEP Freshwater Guidelines		McDonald et al. Freshwater Guidelines		ORNL PRGs	Lowest Secondary Value		Selected Screening Value	
								Lower	Upper	Lower	Upper
	ER-L	ER-M	LEL	SEL	TEC	PEC	PRG	Effects	Effects	Effects	Effects
Alpha-BHC	6	10,000	6	10,000	--	--	--	6	10,000	6	10,000
Alpha-Chlordane	7	6,000	7	6,000	3.24	17.6	4.8	3.24	4.8	7	6,000
Beta-BHC	5	21,000	5	21,000	--	--	--	5	21,000	5	21,000
Delta-BHC	--	--	--	--	--	--	--	--	--	--	--
Dieldrin	2	91,000	2	91,000	1.9	61.8	4.3	1.9	4.3	2	91,000
Endosulfan I	--	--	--	--	--	--	5.5	--	5.5	--	5.5
Endosulfan II	--	--	--	--	--	--	5.5	--	5.5	--	5.5
Endosulfan sulfate	--	--	--	--	--	--	--	--	--	--	--
Endrin	3	130,000	3	130,000	2.22	207	45	2.22	45	3	130,000
Endrin aldehyde	--	--	--	--	--	--	--	--	--	--	--
Endrin ketone	--	--	--	--	--	--	--	--	--	--	--
Gamma-BHC (lindane)	3	1,000	3	1,000	2.37	4.99	0.99	2.37	0.99	3	1,000
Gamma-Chlordane	7	6,000	7	6,000	3.24	17.6	4.8	3.24	4.8	7	6,000
Heptachlor	--	--	--	--	--	--	13,000	--	13,000	--	13,000
Heptachlor epoxide	5	5,000	5	5,000	2.47	16	--	2.47	16	5	5,000
Methoxychlor	--	--	--	--	--	--	19	--	19	--	19
Herbicides (µg/kg)											
2,4,5-T	--	--	--	--	--	--	--	--	--	--	--
2,4,5-TP	--	--	--	--	--	--	--	--	--	--	--
2,4-D	--	--	--	--	--	--	--	--	--	--	--
2,4-DB	--	--	--	--	--	--	--	--	--	--	--
Toxaphene	--	--	--	--	--	--	--	--	--	--	--
PAHs (µg/kg)											
2-Methylnaphthalene	--	--	70	--	--	--	--	70	--	70	--
Acenaphthene	16	500	16	--	--	--	89	16	89	16	500
Acenaphthylene	44	640	44	--	--	--	130	44	130	44	640
Anthracene	85	1,100	220	370,000	57.2	845	250	57.2	250	85	1,100
Benzo(a)anthracene	261	1,600	320	1,480,000	108	1,050	690	108	690	261	1,600
Benzo(a)pyrene	430	1,600	370	1,440,000	150	1,450	394	150	394	430	1,600
Benzo(k)fluoranthene	240	1,340,000	240	1,340,000	--	--	4,000	240	4,000	240	1,340,000
Benzo(b)fluoranthene	--	--	--	--	--	--	4,000	--	4,000	--	4,000
Benzo(g,h,i)perylene	170	320,000	170	320,000	--	--	6,300	170	6,300	170	320,000
Biphenyl	--	--	--	--	--	--	1,100	--	1,100	--	1,100
Chrysene	384	2,800	340	460,000	166	1,290	850	166	850	384	2,800
Dibenzo(a,h)anthracene	63	260	60	130,000	33	--	28.2	33	28.2	63	260
Fluoranthene	600	5,100	750	1,020,000	423	2,230	834	423	834	600	5,100
Fluorene	19	540	190	160,000	77.4	536	140	77.4	140	19	540

TABLE 6-3
SELECTION OF SEDIMENT SCREENING CRITERIA

Chemical	Primary Criteria		Secondary Criteria							Final	
	NJDEP Marine Guidelines		NJDEP Freshwater Guidelines		McDonald et al. Freshwater Guidelines		ORNL PRGs	Lowest Secondary Value		Selected Screening Value	
								Lower	Upper	Lower	Upper
	ER-L	ER-M	LEL	SEL	TEC	PEC	PRG	Effects	Effects	Effects	Effects
Indeno(1,2,3-cd)pyrene	200	320,000	200	320,000	--	--	837	200	837	200	320,000
Naphthalene	160	2,100	160	--	176	561	390	160	390	160	2,100
Phenanthrene	240	1,500	560	950,000	204	1,170	540	204	540	240	1,500
Pyrene	665	2,600	490	850,000	195	1,520	1,400	195	1,400	665	2,600
Total LMW PAHs	--	--	--	--	--	--	3,369	--	3,369	--	3,369
Total HMW PAHs	--	--	--	--	--	--	4,354	--	4,354	--	4,354
Total PAHs	4,000	45,000	4,000	10,000,000	1,610	22,800	13,660	1,610	13,660	4,000	45,000
SVOCs (µg/kg)											
1,2,4-Trichlorobenzene	--	--	--	--	--	--	--	--	--	--	--
1,2-Dichlorobenzene	--	--	--	--	--	--	330	--	330	--	330
1,3-Dichlorobenzene	--	--	--	--	--	--	1,700	--	1,700	--	1,700
1,4-Dichlorobenzene	--	--	--	--	--	--	350	--	350	--	350
2,2'-oxybis(1-Chloropropane)	--	--	--	--	--	--	--	--	--	--	--
2,4,5-Trichlorophenol	--	--	--	--	--	--	--	--	--	--	--
2,4,6-Trichlorophenol	--	--	--	--	--	--	--	--	--	--	--
2,4-Dichlorophenol	--	--	--	--	--	--	--	--	--	--	--
2,4-Dimethylphenol	--	--	--	--	--	--	--	--	--	--	--
2,4-Dinitrophenol	--	--	--	--	--	--	--	--	--	--	--
2,4-Dinitrotoluene	--	--	--	--	--	--	--	--	--	--	--
2,6-Dinitrotoluene	--	--	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	--	--	--	--	--
2-Chlorophenol	--	--	--	--	--	--	--	--	--	--	--
2-Methylphenol	--	--	--	--	--	--	12	--	12	--	12
2-Nitroaniline	--	--	--	--	--	--	--	--	--	--	--
2-Nitrophenol	--	--	--	--	--	--	--	--	--	--	--
3,3'-Dichlorobenzidine	--	--	--	--	--	--	--	--	--	--	--
3-Methylphenol & 4-Methylphenol	--	--	--	--	--	--	--	--	--	--	--
3-Nitroaniline	--	--	--	--	--	--	--	--	--	--	--
4,6-Dinitro-2-methylphenol	--	--	--	--	--	--	--	--	--	--	--
4-Bromophenyl-phenylether	--	--	--	--	--	--	1,200	--	1,200	--	1,200
4-Chloro-3-Methylphenol	--	--	--	--	--	--	--	--	--	--	--
4-Chloroaniline	--	--	--	--	--	--	--	--	--	--	--
4-Chlorophenyl-phenylether	--	--	--	--	--	--	--	--	--	--	--
4-Nitroaniline	--	--	--	--	--	--	--	--	--	--	--
4-Nitrophenol	--	--	--	--	--	--	--	--	--	--	--
bis(2-Chloroethoxy)methane	--	--	--	--	--	--	--	--	--	--	--
bis(2-Chloroethyl)ether	--	--	--	--	--	--	--	--	--	--	--

TABLE 6-3
SELECTION OF SEDIMENT SCREENING CRITERIA

Chemical	Primary Criteria		Secondary Criteria							Final	
	NJDEP Marine Guidelines		NJDEP Freshwater Guidelines		McDonald et al. Freshwater Guidelines		ORNL PRGs	Lowest Secondary Value		Selected Screening Value	
								Lower	Upper	Lower	Upper
	ER-L	ER-M	LEL	SEL	TEC	PEC	PRG	Effects	Effects	Effects	Effects
bis(2-Ethylhexyl)phthalate	--	--	--	--	--	--	2,700	--	2,700	--	2,700
Butylbenzylphthalate	--	--	--	--	--	--	--	--	--	--	--
Carbazole	--	--	--	--	--	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	420	--	420	--	420
Diethylphthalate	--	--	--	--	--	--	610	--	610	--	610
Dimethylphthalate	--	--	--	--	--	--	--	--	--	--	--
Di-n-butylphthalate	--	--	--	--	--	--	240,000	--	240,000	--	240,000
Di-n-octylphthalate	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	20	24,000	20	24,000	--	--	--	20	24,000	20	24,000
Hexachlorobutadiene	--	--	20	--	--	--	--	20	--	20	--
Hexachlorocyclopentadiene	--	--	--	--	--	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	1,000	--	1,000	--	1,000
Isophorone	--	--	--	--	--	--	--	--	--	--	--
Nitrobenzene	--	--	--	--	--	--	--	--	--	--	--
n-Nitroso-di-n-propylamine	--	--	--	--	--	--	--	--	--	--	--
n-Nitrosodiphenylamine	--	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	--	--	--	--	--
Phenol	--	--	--	--	--	--	32	--	32	--	32
VOCs (µg/kg)											
1,1,1-Trichloroethane	--	--	--	--	--	--	9,600	--	9,600	--	9,600
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	5,400	--	5,400	--	5,400
1,1,2-Trichloroethane	--	--	--	--	--	--	9,800	--	9,800	--	9,800
1,1-Dichloroethane	--	--	--	--	--	--	27	--	27	--	27
1,1-Dichloroethene	--	--	--	--	--	--	3,500	--	3,500	--	3,500
1,2-Dichloroethane	--	--	--	--	--	--	4,300	--	4,300	--	4,300
1,2-Dichloroethene (total)	--	--	--	--	--	--	400	--	400	--	400
1,2-Dichloropropane	--	--	--	--	--	--	--	--	--	--	--
2-Butanone	--	--	--	--	--	--	270	--	270	--	270
2-Hexanone	--	--	--	--	--	--	23	--	23	--	23
4-Methyl-2-pentanone	--	--	--	--	--	--	15,000	--	15,000	--	15,000
Acetone	--	--	--	--	--	--	9.1	--	9.1	--	9.1
Benzene	340	--	340	--	--	--	160	340	160	340	160
Bromodichloromethane	--	--	--	--	--	--	--	--	--	--	--
Bromoform	--	--	--	--	--	--	--	--	--	--	--
Bromomethane	--	--	--	--	--	--	--	--	--	--	--
Carbon disulfide	--	--	--	--	--	--	0.86	--	0.86	--	0.86
Carbon tetrachloride	--	--	--	--	--	--	2,000	--	2,000	--	2,000

TABLE 6-3
SELECTION OF SEDIMENT SCREENING CRITERIA

Chemical	Primary Criteria		Secondary Criteria							Final	
	NJDEP Marine Guidelines		NJDEP Freshwater Guidelines		McDonald et al. Freshwater Guidelines		ORNL PRGs	Lowest Secondary Value		Selected Screening Value	
								Lower	Upper	Lower	Upper
	ER-L	ER-M	LEL	SEL	TEC	PEC	PRG	Effects	Effects	Effects	Effects
Chlorobenzene	--	--	--	--	--	--	417	--	417	--	417
Chloroethane	--	--	--	--	--	--	--	--	--	--	--
Chloroform	--	--	--	--	--	--	960	--	960	--	960
Chloromethane	--	--	--	--	--	--	--	--	--	--	--
cis-1,3-Dichloropropene	--	--	--	--	--	--	--	--	--	--	--
Dibromochloromethane	--	--	--	--	--	--	--	--	--	--	--
Ethylbenzene	1,400	--	1,400	--	--	--	5,400	1,400	5,400	1,400	5,400
Methylene chloride	--	--	--	--	--	--	18,000	--	18,000	--	18,000
Styrene	--	--	--	--	--	--	--	--	--	--	--
Tetrachloroethene	450	--	450	--	--	--	3,200	450	3,200	450	3,200
Toluene	2,500	--	--	--	--	--	50	--	50	2,500	50
Total BTEX	--	--	--	--	--	--	--	--	--	--	--
trans-1,3-Dichloropropene	--	--	--	--	--	--	--	--	--	--	--
Trichloroethene	1,600	--	1,600	--	--	--	52,000	1,600	52,000	1,600	52,000
Vinyl Chloride	--	--	--	--	--	--	--	--	--	--	--
Xylenes (total)	120	--	120	--	--	--	160	120	160	120	160

Notes:
NJDEP (1998) Guidance for Sediment Quality Evaluations
Long et al. (1995) Incidence of Adverse Biological Effects within Ranges of Chemical Concentrations in Marine and Estuarine Sediments
Persaud et al. (1993) Guidelines for the protection and management of aquatic sediment quality in Ontario
MacDonald et al. (2000) Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems
Efroymson et al. (1997) Preliminary Remediation Goals for Ecological Endpoints. Oak Ridge National Laboratory (ORNL)

1. mg/kg - milligrams per kilogram
2. pg/g - picograms per gram
3. µg/kg - micrograms per kilogram
4. "--" - No criteria available
5. LEL - Lowest Effects Level
6. SEL - Severe Effects Level
7. TEC - Threshold Effects Concentration
8. PEC - Probable Effects Concentration
9. PRG - Preliminary Remediation Goal
10. SVOC - Semi-Volatile Organic Compound
11. VOC - Volatile Organic Compound
12. LELs, SELs, TECs, and PECs are effects levels for freshwater sediment
13. PRGs were compiled from both freshwater and estuarine effects levels; however, effects levels for metals were developed for use with only marine/estuarine sediment
14. NJDEP SELs for non-polar organics are based on 100% organic carbon

TABLE 6-4
SCREENING EVALUATION OF ALL SURFACE (0-0.5') SEDIMENT SAMPLES (INCLUDING IN-RIVER AND MUDFLATS)

Constituent	N	DF	Sediment Concentrations		Screening Criteria		DF > 10%	USEPA IBC	Max > LEL	No LEL	COPEC?
			Mean	Max	LEL	UEL					
Inorganics (mg/kg)											
Aluminum	56	100%	8,350	18,900	--	--	x			x	**x**
Antimony	56	7%	1.09	10.2	--	--				x	
Arsenic	56	100%	**14.6**	**84.8**	8.2	70	x	x	x		**x**
Barium	56	100%	92.9	430	--	--	x			x	**x**
Beryllium	56	25%	0.702	5.7	--	--	x			x	**x**
Cadmium	56	29%	0.544	**6**	1.2	9.6	x	x	x		**x**
Chromium (Total)	56	100%	**86.4**	**480**	81	370	x		x		**x**
Chromium (Hexavalent)	56	45%	1.51	19.7	--	--	x	x		x	**x**
Cobalt	56	100%	8.77	39.8	--	--	x			x	**x**
Copper	56	100%	**105**	**778**	34	270	x	x	x		**x**
Cyanide	56	18%	0.779	8.3	--	--	x			x	**x**
Iron	56	100%	22,700	60,600	--	--	x			x	**x**
Lead	56	100%	**113**	**709**	47	218	x	x	x		**x**
Manganese	56	100%	403	1,860	--	--	x			x	**x**
Mercury	56	100%	**1.66**	**11.8**	0.15	0.71	x	x	x		**x**
Nickel	56	100%	**26.2**	**164**	21	52	x	x	x		**x**
Selenium	56	79%	1.26	7.1	--	--	x	x		x	**x**
Silver	56	61%	0.755	**3.9**	1	3.7	x	x	x		**x**
Thallium	56	2%	0.881	1.65	--	--				x	
Vanadium	56	100%	27	99.2	--	--	x			x	**x**
Zinc	56	98%	**227**	**3,630**	150	410	x	x	x		**x**
Dioxins/Furans (pg/g)											
WHO Dioxin TEQ (Birds)	56	100%	263	3,770	--	--	x	x		x	**x**
WHO Dioxin TEQ (Fish)	56	100%	221	3,540	--	--	x	x		x	**x**
WHO Dioxin TEQ (Human/Mammal)	56	100%	212	3,510	--	--	x	x		x	**x**
PCBs (pg/g)											
Total Aroclor PCBs	56	46%	**531,000**	**8,000,000**	23,000	180,000	x	x	x		**x**
Total Homolog Groups	56	100%	**1,230,000**	**27,500,000**	23,000	180,000	x	x	x		**x**
Total PCB	56	100%	**1,230,000**	**27,500,000**	23,000	180,000	x	x	x		**x**
WHO PCB Congener TEQ (Birds)	56	100%	255	7,050	--	--	x	x		x	**x**
WHO PCB Congener TEQ (Fish)	56	100%	1.25	27.5	--	--	x	x		x	**x**
WHO PCB Congener TEQ (Human/Mammal)	56	100%	14.4	245	--	--	x	x		x	**x**

TABLE 6-4
SCREENING EVALUATION OF ALL SURFACE (0-0.5') SEDIMENT SAMPLES (INCLUDING IN-RIVER AND MUDFLATS)

Constituent	N	DF	Sediment Concentrations		Screening Criteria		DF > 10%	USEPA IBC	Max > LEL	No LEL	COPEC?
			Mean	Max	LEL	UEL					
Pesticides & Herbicides (µg/kg)											
4,4'-DDD	56	82%	**41.8**	**750**	8	7.8	x	x	x		**x**
4,4'-DDE	56	73%	**33.2**	**650**	2.2	27	x	x	x		**x**
4,4'-DDT	56	27%	6.78	**100**	--	7.8	x	x		x	**x**
Total DDT	56	91%	**79.2**	**1,400**	1.6	46	x	x	x		**x**
Aldrin	56	18%	**2.56**	**16**	2	8,000	x	x	x		**x**
Alpha-BHC	56	57%	2.15	**20.5**	6	10,000	x	x	x		**x**
Alpha-Chlordane	56	55%	6.24	**43**	7	6,000	x	x	x		**x**
Beta-BHC	56	4%	3.49	**71**	5	21,000		x	x		
Delta-BHC	56	13%	2.07	20.5	--	--	x	x		x	**x**
Dieldrin	56	73%	**15.4**	**470**	2	91,000	x	x	x		**x**
Endosulfan I	56	25%	**6.71**	**140**	--	5.5	x	x		x	**x**
Endosulfan II	56	32%	**8.95**	**79**	--	5.5	x	x		x	**x**
Endosulfan Sulfate	56	7%	3.84	56	--	--				x	
Endrin	56	57%	**14**	**320**	3	130,000	x	x	x		**x**
Endrin Aldehyde	56	70%	47.4	1,500	--	--	x			x	**x**
Endrin Ketone	56	14%	3.53	26	--	--	x			x	**x**
Gamma-BHC (Lindane)	56	5%	2.08	**20.5**	3	1,000		x	x		
Gamma-Chlordane	56	63%	6.88	**30**	7	6,000	x	x	x		**x**
Heptachlor	56	9%	1.84	12	--	13,000		x		x	
Heptachlor Epoxide	56	21%	3.02	**28**	5	5,000	x	x	x		**x**
Methoxychlor	56	5%	4.1	**40**	--	19		x		x	
Toxaphene	56	0%	83.4	800	--	--		x		x	
2,4,5-T	56	0%	18	33	--	--				x	
2,4,5-TP	56	0%	18	33	--	--				x	
2,4-D	56	0%	71.8	130	--	--				x	
2,4-DB	56	0%	71.8	130	--	--				x	
SVOCs (µg/kg)											
1,2,4-Trichlorobenzene	56	32%	7,130	310,000	--	--	x	x		x	**x**
1,2-Dichlorobenzene	56	25%	**7,040**	**310,000**	--	330	x	x		x	**x**
1,3-Dichlorobenzene	56	27%	**7,060**	**310,000**	--	1,700	x	x		x	**x**
1,4-Dichlorobenzene	56	54%	**6,980**	**310,000**	--	350	x	x		x	**x**
2,2'-oxybis(1-Chloropropane)	56	0%	7,130	310,000	--	--				x	
2,4,5-Trichlorophenol	56	0%	7,130	310,000	--	--				x	

TABLE 6-4
SCREENING EVALUATION OF ALL SURFACE (0-0.5') SEDIMENT SAMPLES (INCLUDING IN-RIVER AND MUDFLATS)

Constituent	N	DF	Sediment Concentrations		Screening Criteria		DF > 10%	USEPA IBC	Max > LEL	No LEL	COPEC?
			Mean	Max	LEL	UEL					
2,4,6-Trichlorophenol	56	0%	7,130	310,000	--	--				x	
2,4-Dichlorophenol	56	2%	7,130	310,000	--	--				x	
2,4-Dimethylphenol	56	2%	7,120	310,000	--	--				x	
2,4-Dinitrophenol	56	0%	34,500	1,500,000	--	--				x	
2,4-Dinitrotoluene	56	0%	7,130	310,000	--	--				x	
2,6-Dinitrotoluene	56	0%	7,130	310,000	--	--				x	
2-Chloronaphthalene	56	0%	7,130	310,000	--	--				x	
2-Chlorophenol	56	0%	7,130	310,000	--	--				x	
2-Methylnaphthalene	56	77%	**30,000**	**1,600,000**	70	--	x		x		**x**
2-Methylphenol	56	0%	**7,130**	**310,000**	--	12				x	
2-Nitroaniline	56	0%	34,500	1,500,000	--	--				x	
2-Nitrophenol	56	0%	7,130	310,000	--	--				x	
3,3'-Dichlorobenzidine	56	0%	34,500	1,500,000	--	--				x	
3-Methylphenol & 4-Methylphenol	56	0%	7,130	310,000	--	--				x	
3-Nitroaniline	56	0%	34,500	1,500,000	--	--				x	
4,6-Dinitro-2-methylphenol	56	0%	34,500	1,500,000	--	--				x	
4-Bromophenyl-phenylether	56	0%	**7,130**	**310,000**	--	1,200		x		x	
4-Chloro-3-Methylphenol	56	0%	7,130	310,000	--	--				x	
4-Chloroaniline	56	5%	7,100	310,000	--	--				x	
4-Chlorophenyl-phenylether	56	0%	7,130	310,000	--	--		x		x	
4-Nitroaniline	56	0%	34,500	1,500,000	--	--				x	
4-Nitrophenol	56	0%	34,500	1,500,000	--	--				x	
Acenaphthene	56	88%	**75,900**	**4,000,000**	16	500	x	x	x		**x**
Acenaphthylene	56	88%	**10,200**	**460,000**	44	640	x	x	x		**x**
Anthracene	56	93%	**77,100**	**4,000,000**	85	1,100	x	x	x		**x**
Benzo(a)anthracene	56	100%	**56,400**	**2,700,000**	261	1,600	x	x	x		**x**
Benzo(a)pyrene	56	98%	**44,200**	**2,100,000**	430	1,600	x	x	x		**x**
Benzo(b)fluoranthene	56	96%	**50,300**	**2,400,000**	--	4,000	x	x		x	**x**
Benzo(g,h,i)perylene	56	95%	**14,900**	**660,000**	170	320,000	x	x	x		**x**
Benzo(k)fluoranthene	56	93%	**19,200**	**920,000**	240	1,340,000	x	x	x		**x**
bis(2-Chloroethoxy)methane	56	0%	7,130	310,000	--	--				x	
bis(2-Chloroethyl)ether	56	0%	7,130	310,000	--	--				x	
bis(2-Ethylhexyl)phthalate	56	73%	**8,370**	**310,000**	--	2,700	x			x	**x**
Butylbenzylphthalate	56	23%	7,100	310,000	--	--	x			x	**x**

TABLE 6-4
SCREENING EVALUATION OF ALL SURFACE (0-0.5') SEDIMENT SAMPLES (INCLUDING IN-RIVER AND MUDFLATS)

Constituent	N	DF	Sediment Concentrations		Screening Criteria		DF > 10%	USEPA IBC	Max > LEL	No LEL	COPEC?
			Mean	Max	LEL	UEL					
Carbazole	56	57%	7,200	370,000	--	--	x			x	**x**
Chrysene	56	100%	**44,800**	**2,100,000**	384	2,800	x	x	x		**x**
Dibenzo(a,h)anthracene	56	84%	**4,930**	**220,000**	63	260	x	x	x		**x**
Dibenzofuran	56	75%	**36,600**	**2,000,000**	--	420	x			x	**x**
Diethylphthalate	56	0%	**7,130**	**310,000**	--	610				x	
Dimethylphthalate	56	0%	7,130	310,000	--	--				x	
Di-n-Butylphthalate	56	2%	7,120	**310,000**	--	240,000				x	
Di-n-Octylphthalate	56	0%	7,130	310,000	--	--				x	
Fluoranthene	56	100%	**197,000**	**10,000,000**	600	5,100	x	x	x		**x**
Fluorene	56	77%	**55,900**	**3,000,000**	19	540	x	x	x		**x**
Hexachlorobenzene	56	2%	**7,130**	**310,000**	20	24,000		x	x		
Hexachlorobutadiene	56	0%	**7,130**	**310,000**	20	--		x	x		
Hexachlorocyclopentadiene	56	0%	34,500	1,500,000	--	--		x		x	
Hexachloroethane	56	0%	**7,130**	**310,000**	--	1,000		x		x	
Indeno(1,2,3-cd)pyrene	56	95%	**15,800**	**720,000**	200	320,000	x	x	x		**x**
Isophorone	56	0%	7,130	310,000	--	--				x	
Naphthalene	56	80%	**61,400**	**3,200,000**	160	2,100	x		x		**x**
Nitrobenzene	56	0%	7,130	310,000	--	--				x	
N-Nitroso-di-n-propylamine	56	0%	7,130	310,000	--	--				x	
N-Nitrosodiphenylamine	56	0%	7,130	310,000	--	--				x	
Pentachlorophenol	56	0%	34,500	1,500,000	--	--		x		x	
Phenanthrene	56	98%	**259,000**	**14,000,000**	240	1,500	x	x	x		**x**
Phenol	56	0%	**7,130**	**310,000**	--	32				x	
Pyrene	56	98%	**97,800**	**4,700,000**	665	2,600	x	x	x		**x**
Total HMW PAHs	56	100%	**545,000**	**26,500,000**	--	4,354	x			x	**x**
Total LMW PAHs	56	98%	**570,000**	**30,300,000**	--	3,369	x			x	**x**
Total PAHs	56	100%	**1,110,000**	**56,800,000**	4,000	45,000	x		x		**x**
VOCs (µg/kg)											
1,1,1-Trichloroethane	56	0%	7.22	84	--	9,600				x	
1,1,2,2-Tetrachloroethane	56	0%	7.22	84	--	5,400				x	
1,1,2-Trichloroethane	56	0%	7.22	84	--	9,800				x	
1,1-Dichloroethane	56	0%	7.22	**84**	--	27				x	
1,1-Dichloroethene	56	0%	7.22	84	--	3,500				x	
1,2-Dichloroethane	56	0%	7.22	84	--	4,300				x	

TABLE 6-4
SCREENING EVALUATION OF ALL SURFACE (0-0.5') SEDIMENT SAMPLES (INCLUDING IN-RIVER AND MUDFLATS)

Constituent	N	DF	Sediment Concentrations		Screening Criteria		DF > 10%	USEPA IBC	Max > LEL	No LEL	COPEC?
			Mean	Max	LEL	UEL					
1,2-Dichloroethene (total)	56	0%	7.22	84	--	400				x	
1,2-Dichloropropane	56	0%	7.22	84	--	--				x	
2-Butanone	56	27%	10.9	84	--	270	x			x	**x**
2-Hexanone	56	0%	7.22	**84**	--	23				x	
4-Methyl-2-pentanone	56	0%	7.22	84	--	15,000				x	
Acetone	56	34%	**31.9**	**341**	--	9.1	x			x	**x**
Benzene	56	4%	30.6	**1,300**	340	160			x		
Bromodichloromethane	56	0%	7.22	84	--	--				x	
Bromoform	56	0%	7.22	84	--	--				x	
Bromomethane	56	0%	7.22	84	--	--				x	
Carbon Disulfide	56	9%	**6.94**	**84**	--	0.86				x	
Carbon Tetrachloride	56	0%	7.22	84	--	2,000				x	
Chlorobenzene	56	5%	7.28	84	--	417				x	
Chloroethane	56	0%	7.22	84	--	--				x	
Chloroform	56	4%	7.02	84	--	960				x	
Chloromethane	56	0%	7.22	84	--	--				x	
cis-1,3-Dichloropropene	56	0%	7.22	84	--	--				x	
Dibromochloromethane	56	0%	7.22	84	--	--				x	
Ethylbenzene	56	7%	104	**5,300**	1,400	5,400			x		
Methylene Chloride	56	0%	5.91	83.2	--	18,000				x	
Styrene	56	0%	7.22	84	--	--				x	
Tetrachloroethene	56	0%	7.22	84	450	3,200					
Toluene	56	18%	7.84	**84**	2,500	50	x				
Total BTEX	56	21%	144	6820	--	--	x			x	**x**
trans-1,3-Dichloropropene	56	0%	7.22	84	--	--				x	
Trichloroethene	56	0%	7.22	84	1,600	52,000					

TABLE 6-4
SCREENING EVALUATION OF ALL SURFACE (0-0.5') SEDIMENT SAMPLES (INCLUDING IN-RIVER AND MUDFLATS)

Constituent	N	DF	Sediment Concentrations		Screening Criteria		DF > 10%	USEPA IBC	Max > LEL	No LEL	COPEC?
			Mean	Max	LEL	UEL					
Vinyl Chloride	56	0%	7.22	84	--	--				x	
Xylenes (total)	56	5%	23.3	**200**	120	160			x		

Notes:
1. N - Sample number
2. DF - Detection Frequency
3. LEL - Lower Effects Level
4. UEL - Upper Effects Level
5. "--" - No Criteria Available
6. IBC - Important Bioaccumulative Compound, as described by USEPA (2000)
7. COPEC - Constituent of Potential Ecological Concern
8. TCDD - 2,3,7,8-Tetrachlorodibenzo-p-dioxin
9. TCDF - 2,3,7,8-Tetrachlordibenzofuran
10. TEQ - Toxic Equivalent
11. WHO - World Health Organization
12. PCB - Polychlorinated Biphenyl
13. SVOC - Semi-Volatile Organic Compound
14. USEPA - United States Environmental Protection Agency
15. VOC - Volatile Organic Compound
16. mg/kg - milligrams per kilogram
17. pg/g - picograms per gram
18. µg/kg - micrograms per kilogram
19. Mean values were calculated using one-half the detection limit for non-detects
20. Field and duplicate sample results were averaged together to create one result
21. WHO TEQs were calculated using 1/2 of the detection limit for non-detects, according to the method described in Van den Berg et al. (2006)

COPEC Selection Decision Criteria:
1 - Detection Frequency < 10% → Not Retained as a COPEC
2 - USEPA IBC → Retained as COPEC
3 - Maximum Concentration > LEL → Retained as a COPEC
4 - No LEL Available → Retained as a COPEC
5 - Does Not Meet Criteria 2,3, or 4 → Not Retained as a COPEC

- Concentration exceeds LEL

- Concentration exceeds UEL

TABLE 6-5
SCREENING EVALUATION OF MUDFLAT SURFACE (0-0.5') SEDIMENT SAMPLES

Constituent	N	DF	Sediment Concentrations		Screening Criteria		DF > 10%	USEPA IBC	Max > LEL	No LEL	COPEC?
			Mean	Max	LEL	UEL					
Inorganics (mg/kg)											
Aluminum	19	100%	9,040	16,400	--	--	x			x	**x**
Antimony	19	5%	1.04	1.65	--	--				x	
Arsenic	19	100%	**12.3**	**19.3**	8.2	70	x	x	x		**x**
Barium	19	100%	109	312	--	--	x			x	**x**
Beryllium	19	26%	0.641	1.5	--	--	x			x	**x**
Cadmium	19	42%	0.516	1	1.2	9.6	x	x			**x**
Chromium (Total)	19	100%	**98.7**	**196**	81	370	x		x		**x**
Chromium (Hexavalent)	19	32%	1.54	8.1	--	--	x	x		x	**x**
Cobalt	19	100%	8.98	13.2	--	--	x			x	**x**
Copper	19	100%	**173**	**778**	34	270	x	x	x		**x**
Cyanide	19	21%	1.06	7.1	--	--	x			x	**x**
Iron	19	100%	28,300	60,600	--	--	x			x	**x**
Lead	19	100%	**140**	**373**	47	218	x	x	x		**x**
Manganese	19	100%	316	513	--	--	x			x	**x**
Mercury	19	100%	**1.83**	**3.4**	0.15	0.71	x	x	x		**x**
Nickel	19	100%	**33.4**	**128**	21	52	x	x	x		**x**
Selenium	19	100%	1.63	2.9	--	--	x	x		x	**x**
Silver	19	95%	**1.23**	**2.4**	1	3.7	x	x	x		**x**
Thallium	19	5%	1.08	1.65	--	--				x	
Vanadium	19	100%	32.2	45.6	--	--	x			x	**x**
Zinc	19	100%	**259**	**564**	150	410	x	x	x		**x**
Dioxins/Furans (pg/g)											
WHO Dioxin TEQ (Birds)	19	100%	195	453	--	--	x	x		x	**x**
WHO Dioxin TEQ (Fish)	19	100%	158	400	--	--	x	x		x	**x**
WHO Dioxin TEQ (Human/Mammal)	19	100%	154	399	--	--	x	x		x	**x**
PCBs (pg/g)											
Total Aroclor PCBs	19	74%	**1,260,000**	**8,000,000**	23,000	180,000	x	x	x		**x**
Total Homolog Groups	19	100%	**3,170,000**	**27,500,000**	23,000	180,000	x	x	x		**x**
Total PCB	19	100%	**3,170,000**	**27,500,000**	23,000	180,000	x	x	x		**x**
WHO PCB Congener TEQ (Birds)	19	100%	646	7,050	--	--	x	x		x	**x**
WHO PCB Congener TEQ (Fish)	19	100%	2.95	27.5	--	--	x	x		x	**x**
WHO PCB Congener TEQ (Human/Mammal)	19	100%	30.8	245	--	--	x	x		x	**x**

TABLE 6-5
SCREENING EVALUATION OF MUDFLAT SURFACE (0-0.5') SEDIMENT SAMPLES

Constituent	N	DF	Sediment Concentrations		Screening Criteria		DF > 10%	USEPA IBC	Max > LEL	No LEL	COPEC?
			Mean	Max	LEL	UEL					
Pesticides & Herbicides (µg/kg)											
4,4'-DDD	19	95%	**30.3**	**150**	8	7.8	x	x	x		**x**
4,4'-DDE	19	95%	**24.2**	**68**	2.2	27	x	x	x		**x**
4,4'-DDT	19	47%	7.34	**48**	--	7.8	x	x		x	**x**
Total DDT	19	100%	**60.5**	**218**	1.6	46	x	x	x		**x**
Aldrin	19	21%	**3.47**	**16**	2	8,000	x	x	x		**x**
Alpha-BHC	19	68%	2.08	4.9	6	10,000	x	x			**x**
Alpha-Chlordane	19	74%	**10.2**	**43**	7	6,000	x	x	x		**x**
Beta-BHC	19	11%	**5.9**	**71**	5	21,000	x	x	x		**x**
Delta-BHC	19	11%	1.75	2.8	--	--	x	x		x	**x**
Dieldrin	19	89%	**7.66**	**33**	2	91,000	x	x	x		**x**
Endosulfan I	19	0%	1.86	2.8	--	5.5		x		x	
Endosulfan II	19	53%	**14.9**	**79**	--	5.5	x	x		x	**x**
Endosulfan Sulfate	19	5%	1.94	4.1	--	--				x	
Endrin	19	79%	**11.2**	**44**	3	130,000	x	x	x		**x**
Endrin Aldehyde	19	79%	23.9	150	--	--	x			x	**x**
Endrin Ketone	19	21%	3.7	14	--	--	x			x	**x**
Gamma-BHC (Lindane)	19	0%	1.86	2.8	3	1,000		x			
Gamma-Chlordane	19	84%	**10.7**	**26**	7	6,000	x	x	x		**x**
Heptachlor	19	0%	1.86	2.8	--	13,000		x		x	
Heptachlor Epoxide	19	11%	2.53	**12**	5	5,000	x	x	x		**x**
Methoxychlor	19	5%	3.53	5.5	--	19		x		x	
Toxaphene	19	0%	73	110	--	--		x		x	
2,4,5-T	19	0%	21.9	33	--	--				x	
2,4,5-TP	19	0%	21.9	33	--	--				x	
2,4-D	19	0%	87.5	130	--	--				x	
2,4-DB	19	0%	87.5	130	--	--				x	
SVOCs (µg/kg)											
1,2,4-Trichlorobenzene	19	42%	449	2,600	--	--	x	x		x	**x**
1,2-Dichlorobenzene	19	42%	**409**	**2,600**	--	330	x	x		x	**x**
1,3-Dichlorobenzene	19	32%	476	**2,600**	--	1,700	x	x		x	**x**
1,4-Dichlorobenzene	19	74%	221	**550**	--	350	x	x		x	**x**
2,2'-oxybis(1-Chloropropane)	19	0%	640	2,600	--	--				x	
2,4,5-Trichlorophenol	19	0%	640	2,600	--	--				x	

TABLE 6-5
SCREENING EVALUATION OF MUDFLAT SURFACE (0-0.5') SEDIMENT SAMPLES

Constituent	N	DF	Sediment Concentrations		Screening Criteria		DF > 10%	USEPA IBC	Max > LEL	No LEL	COPEC?
			Mean	Max	LEL	UEL					
2,4,6-Trichlorophenol	19	0%	640	2,600	--	--				x	
2,4-Dichlorophenol	19	0%	640	2,600	--	--				x	
2,4-Dimethylphenol	19	5%	614	2,600	--	--				x	
2,4-Dinitrophenol	19	0%	3,100	12,500	--	--				x	
2,4-Dinitrotoluene	19	0%	640	2,600	--	--				x	
2,6-Dinitrotoluene	19	0%	640	2,600	--	--				x	
2-Chloronaphthalene	19	0%	640	2,600	--	--				x	
2-Chlorophenol	19	0%	640	2,600	--	--				x	
2-Methylnaphthalene	19	79%	**311**	**2,600**	70	--	x		x		**x**
2-Methylphenol	19	0%	**640**	**2,600**	--	12				x	
2-Nitroaniline	19	0%	3,100	12,500	--	--				x	
2-Nitrophenol	19	0%	640	2,600	--	--				x	
3,3'-Dichlorobenzidine	19	0%	3,100	12,500	--	--				x	
3-Methylphenol & 4-Methylphenol	19	0%	640	2,600	--	--				x	
3-Nitroaniline	19	0%	3,100	12,500	--	--				x	
4,6-Dinitro-2-methylphenol	19	0%	3,100	12,500	--	--				x	
4-Bromophenyl-phenylether	19	0%	640	**2,600**	--	1,200		x		x	
4-Chloro-3-Methylphenol	19	0%	640	2,600	--	--				x	
4-Chloroaniline	19	11%	583	2,600	--	--	x			x	**x**
4-Chlorophenyl-phenylether	19	0%	640	2,600	--	--		x		x	
4-Nitroaniline	19	0%	3,100	12,500	--	--				x	
4-Nitrophenol	19	0%	3,100	12,500	--	--				x	
Acenaphthene	19	79%	**371**	**2,600**	16	500	x	x	x		**x**
Acenaphthylene	19	84%	**745**	**2,600**	44	640	x	x	x		**x**
Anthracene	19	95%	**817**	**1,900**	85	1,100	x	x	x		**x**
Benzo(a)anthracene	19	100%	**2,050**	**4,700**	261	1,600	x	x	x		**x**
Benzo(a)pyrene	19	95%	**2,350**	**5,400**	430	1,600	x	x	x		**x**
Benzo(b)fluoranthene	19	95%	2,640	**6,200**	--	4,000	x	x		x	**x**
Benzo(g,h,i)perylene	19	95%	**1,130**	**2,700**	170	320,000	x	x	x		**x**
Benzo(k)fluoranthene	19	95%	**993**	**2,400**	240	1,340,000	x	x	x		**x**
bis(2-Chloroethoxy)methane	19	0%	640	2,600	--	--				x	
bis(2-Chloroethyl)ether	19	0%	640	2,600	--	--				x	
bis(2-Ethylhexyl)phthalate	19	89%	**3,980**	**35,000**	--	2,700	x			x	**x**
Butylbenzylphthalate	19	37%	456	2,600	--	--	x			x	**x**

TABLE 6-5
SCREENING EVALUATION OF MUDFLAT SURFACE (0-0.5') SEDIMENT SAMPLES

Constituent	N	DF	Sediment Concentrations		Screening Criteria		DF > 10%	USEPA IBC	Max > LEL	No LEL	COPEC?
			Mean	Max	LEL	UEL					
Carbazole	19	74%	325	2,600	--	--	x			x	**x**
Chrysene	19	100%	**2,060**	**4,800**	384	2,800	x	x	x		**x**
Dibenzo(a,h)anthracene	19	84%	**500**	**2,600**	63	260	x	x	x		**x**
Dibenzofuran	19	79%	299	**2,600**	--	420	x			x	**x**
Diethylphthalate	19	0%	**640**	**2,600**	--	610				x	
Dimethylphthalate	19	0%	640	2,600	--	--				x	
Di-n-Butylphthalate	19	5%	619	2,600	--	240,000				x	
Di-n-Octylphthalate	19	0%	640	2,600	--	--				x	
Fluoranthene	19	100%	**3,640**	**8,600**	600	5,100	x	x	x		**x**
Fluorene	19	79%	**386**	**2,600**	19	540	x	x	x		**x**
Hexachlorobenzene	19	0%	**640**	**2,600**	20	24,000		x	x		
Hexachlorobutadiene	19	0%	**640**	**2,600**	20	--		x	x		
Hexachlorocyclopentadiene	19	0%	3,100	12,500	--	--		x		x	
Hexachloroethane	19	0%	640	**2,600**	--	1,000		x		x	
Indeno(1,2,3-cd)pyrene	19	100%	**1,040**	**2,600**	200	320,000	x	x	x		**x**
Isophorone	19	0%	640	2,600	--	--				x	
Naphthalene	19	74%	**558**	**2,600**	160	2,100	x		x		**x**
Nitrobenzene	19	0%	640	2,600	--	--				x	
N-Nitroso-di-n-propylamine	19	0%	640	2,600	--	--				x	
N-Nitrosodiphenylamine	19	0%	640	2,600	--	--				x	
Pentachlorophenol	19	0%	3,100	12,500	--	--		x		x	
Phenanthrene	19	100%	**920**	**3,200**	240	1,500	x	x	x		**x**
Phenol	19	0%	**640**	**2,600**	--	32				x	
Pyrene	19	95%	**3,080**	**6,700**	665	2,600	x	x	x		**x**
Total HMW PAHs	19	100%	**19,200**	**42,200**	--	4,354	x			x	**x**
Total LMW PAHs	19	100%	3,050	**8,750**	--	3,369	x			x	**x**
Total PAHs	19	100%	**22,200**	**47,600**	4,000	45,000	x		x		**x**
VOCs (µg/kg)											
1,1,1-Trichloroethane	19	0%	7.36	13.5	--	9,600				x	
1,1,2,2-Tetrachloroethane	19	0%	7.36	13.5	--	5,400				x	
1,1,2-Trichloroethane	19	0%	7.36	13.5	--	9,800				x	
1,1-Dichloroethane	19	0%	7.36	13.5	--	27				x	
1,1-Dichloroethene	19	0%	7.36	13.5	--	3,500				x	
1,2-Dichloroethane	19	0%	7.36	13.5	--	4,300				x	

TABLE 6-5
SCREENING EVALUATION OF MUDFLAT SURFACE (0-0.5') SEDIMENT SAMPLES

Constituent	N	DF	Sediment Concentrations		Screening Criteria		DF > 10%	USEPA IBC	Max > LEL	No LEL	COPEC?
			Mean	Max	LEL	UEL					
1,2-Dichloroethene (total)	19	0%	7.36	13.5	--	400				x	
1,2-Dichloropropane	19	0%	7.36	13.5	--	--				x	
2-Butanone	19	32%	9.37	26	--	270	x			x	**x**
2-Hexanone	19	0%	7.36	13.5	--	23				x	
4-Methyl-2-pentanone	19	0%	7.36	13.5	--	15,000				x	
Acetone	19	26%	**29.9**	**55**	--	9.1	x			x	**x**
Benzene	19	0%	7.36	13.5	340	160					
Bromodichloromethane	19	0%	7.36	13.5	--	--				x	
Bromoform	19	0%	7.36	13.5	--	--				x	
Bromomethane	19	0%	7.36	13.5	--	--				x	
Carbon Disulfide	19	5%	**7.05**	**13.5**	--	0.86				x	
Carbon Tetrachloride	19	0%	7.36	13.5	--	2,000				x	
Chlorobenzene	19	11%	7.63	14	--	417	x			x	**x**
Chloroethane	19	0%	7.36	13.5	--	--				x	
Chloroform	19	5%	7.16	13.5	--	960				x	
Chloromethane	19	0%	7.36	13.5	--	--				x	
cis-1,3-Dichloropropene	19	0%	7.36	13.5	--	--				x	
Dibromochloromethane	19	0%	7.36	13.5	--	--				x	
Ethylbenzene	19	0%	7.36	13.5	1,400	5,400					
Methylene Chloride	19	0%	6	9.5	--	18,000				x	
Styrene	19	0%	7.36	13.5	--	--				x	
Tetrachloroethene	19	0%	7.36	13.5	450	3,200					
Toluene	19	5%	7.13	13.5	2,500	50					
Total BTEX	19	5%	21.2	40.5	--	--				x	
trans-1,3-Dichloropropene	19	0%	7.36	13.5	--	--				x	
Trichloroethene	19	0%	7.36	13.5	1,600	52,000					

TABLE 6-5
SCREENING EVALUATION OF MUDFLAT SURFACE (0-0.5') SEDIMENT SAMPLES

Constituent	N	DF	Sediment Concentrations		Screening Criteria		DF > 10%	USEPA IBC	Max > LEL	No LEL	COPEC?
			Mean	Max	LEL	UEL					
Vinyl Chloride	19	0%	7.36	13.5	--	--				x	
Xylenes (total)	19	0%	22.1	40.5	120	160					

Notes:
1. N - Sample number
2. DF - Detection Frequency
3. LEL - Lower Effects Level
4. UEL - Upper Effects Level
5. "--" - No Criteria Available
6. IBC - Important Bioaccumulative Compound, as described by USEPA (2000)
7. COPEC - Constituent of Potential Ecological Concern
8. TCDD - 2,3,7,8-Tetrachlorodibenzo-p-dioxin
9. TCDF - 2,3,7,8-Tetrachlordibenzofuran
10. TEQ - Toxic Equivalent
11. WHO - World Health Organization
12. PCB - Polychlorinated Biphenyl
13. SVOC - Semi-Volatile Organic Compound
14. USEPA - United States Environmental Protection Agency
15. VOC - Volatile Organic Compound
16. mg/kg - milligrams per kilogram
17. pg/g - picograms per gram
18. µg/kg - micrograms per kilogram
19. Mean values were calculated using one-half the detection limit for non-detects
20. Field and duplicate sample results were averaged together to create one result
21. WHO TEQs were calculated using 1/2 of the detection limit for non-detects, according to the method described in Van den Berg et al. (2006)

COPEC Selection Decision Criteria:
1 - Detection Frequency < 10% → Not Retained as a COPEC
2 - USEPA IBC → Retained as COPEC
3 - Maximum Concentration > LEL → Retained as a COPEC
4 - No LEL Available → Retained as a COPEC
5 - Does Not Meet Criteria 2,3, or 4 → Not Retained as a COPEC

- Concentration exceeds LEL

- Concentration exceeds UEL

TABLE 6-6
SCREENING EVALUATION OF IN-RIVER SURFACE (0-0.5') SEDIMENT SAMPLES

Constituent	N	DF	Sediment Concentrations		Screening Criteria		DF > 10%	USEPA IBC	Max > LEL	No LEL	COPEC?
			Mean	Max	LEL	UEL					
Inorganics (mg/kg)											
Aluminum	37	100%	8,000	18,900	--	--	x			x	**x**
Antimony	37	8%	1.12	10.2	--	--				x	
Arsenic	37	100%	**15.7**	**84.8**	8.2	70	x	x	x		**x**
Barium	37	100%	84.4	430	--	--	x			x	**x**
Beryllium	37	24%	0.733	5.7	--	--	x			x	**x**
Cadmium	37	22%	0.56	**6**	1.2	9.6	x	x	x		**x**
Chromium (Total)	37	100%	80.1	**480**	81	370	x		x		**x**
Chromium (Hexavalent)	37	51%	1.5	19.7	--	--	x	x		x	**x**
Cobalt	37	100%	8.66	39.8	--	--	x			x	**x**
Copper	37	100%	**69.8**	**585**	34	270	x	x	x		**x**
Cyanide	37	16%	0.635	8.3	--	--	x			x	**x**
Iron	37	100%	19,800	34,800	--	--	x			x	**x**
Lead	37	100%	**99.9**	**709**	47	218	x	x	x		**x**
Manganese	37	100%	447	1,860	--	--	x			x	**x**
Mercury	37	100%	**1.59**	**11.8**	0.15	0.71	x	x	x		**x**
Nickel	37	100%	**22.5**	**164**	21	52	x	x	x		**x**
Selenium	37	68%	1.07	7.1	--	--	x	x		x	**x**
Silver	37	43%	0.525	**3.9**	1	3.7	x	x	x		**x**
Thallium	37	0%	0.778	1.2	--	--				x	
Vanadium	37	100%	24.4	99.2	--	--	x			x	**x**
Zinc	37	97%	**210**	**3,630**	150	410	x	x	x		**x**
Dioxins/Furans (pg/g)											
WHO Dioxin TEQ (Birds)	37	100%	297	3,770	--	--	x	x		x	**x**
WHO Dioxin TEQ (Fish)	37	100%	254	3,540	--	--	x	x		x	**x**
WHO Dioxin TEQ (Human/Mammal)	37	100%	241	3,510	--	--	x	x		x	**x**
PCBs (pg/g)											
Total Aroclor PCBs	37	32%	**155,000**	**2,320,000**	23,000	180,000	x	x	x		**x**
Total Homolog Groups	37	100%	**237,000**	**2,270,000**	23,000	180,000	x	x	x		**x**
Total PCB	37	100%	**237,000**	**2,270,000**	23,000	180,000	x	x	x		**x**
WHO PCB Congener TEQ (Birds)	37	100%	54.4	476	--	--	x	x		x	**x**
WHO PCB Congener TEQ (Fish)	37	100%	0.379	3.55	--	--	x	x		x	**x**
WHO PCB Congener TEQ (Human/Mammal)	37	100%	5.91	81.6	--	--	x	x		x	**x**

TABLE 6-6
SCREENING EVALUATION OF IN-RIVER SURFACE (0-0.5') SEDIMENT SAMPLES

Constituent	N	DF	Sediment Concentrations		Screening Criteria		DF > 10%	USEPA IBC	Max > LEL	No LEL	COPEC?
			Mean	Max	LEL	UEL					
Pesticides & Herbicides (µg/kg)											
4,4'-DDD	37	76%	**47.8**	**750**	8	7.8	x	x	x		**x**
4,4'-DDE	37	62%	**37.8**	**650**	2.2	27	x	x	x		**x**
4,4'-DDT	37	16%	6.49	**100**	--	7.8	x	x		x	**x**
Total DDT	37	86%	**88.8**	**1,400**	1.6	46	x	x	x		**x**
Aldrin	37	16%	**2.09**	**10.5**	2	8,000	x	x	x		**x**
Alpha-BHC	37	51%	2.19	**20.5**	6	10,000	x	x	x		**x**
Alpha-Chlordane	37	46%	4.21	**38**	7	6,000	x	x	x		**x**
Beta-BHC	37	0%	2.25	**20.5**	5	21,000		x	x		
Delta-BHC	37	14%	2.23	20.5	--	--	x	x		x	**x**
Dieldrin	37	65%	**19.4**	**470**	2	91,000	x	x	x		**x**
Endosulfan I	37	38%	**9.2**	**140**	--	5.5	x	x		x	**x**
Endosulfan II	37	22%	**5.86**	**58**	--	5.5	x	x		x	**x**
Endosulfan Sulfate	37	8%	4.82	56	--	--				x	
Endrin	37	46%	**15.4**	**320**	3	130,000	x	x	x		**x**
Endrin Aldehyde	37	65%	59.5	1,500	--	--	x			x	**x**
Endrin Ketone	37	11%	3.44	26	--	--	x			x	**x**
Gamma-BHC (Lindane)	37	8%	2.19	**20.5**	3	1,000		x	x		
Gamma-Chlordane	37	51%	4.9	**30**	7	6,000	x	x	x		**x**
Heptachlor	37	14%	1.84	12	--	13,000	x	x		x	**x**
Heptachlor Epoxide	37	27%	3.27	**28**	5	5,000	x	x	x		**x**
Methoxychlor	37	5%	4.4	**40**	--	19		x		x	
Toxaphene	37	0%	88.7	800	--	--		x		x	
2,4,5-T	37	0%	16	24.3	--	--				x	
2,4,5-TP	37	0%	16	24.3	--	--				x	
2,4-D	37	0%	63.8	95	--	--				x	
2,4-DB	37	0%	63.8	95	--	--				x	
SVOCs (µg/kg)											
1,2,4-Trichlorobenzene	37	27%	10,600	310,000	--	--	x	x		x	**x**
1,2-Dichlorobenzene	37	16%	**10,400**	**310,000**	--	330	x	x		x	**x**
1,3-Dichlorobenzene	37	24%	**10,400**	**310,000**	--	1,700	x	x		x	**x**
1,4-Dichlorobenzene	37	43%	**10,400**	**310,000**	--	350	x	x		x	**x**
2,2'-oxybis(1-Chloropropane)	37	0%	10,500	310,000	--	--				x	
2,4,5-Trichlorophenol	37	0%	10,500	310,000	--	--				x	

TABLE 6-6
SCREENING EVALUATION OF IN-RIVER SURFACE (0-0.5') SEDIMENT SAMPLES

Constituent	N	DF	Sediment Concentrations		Screening Criteria		DF > 10%	USEPA IBC	Max > LEL	No LEL	COPEC?
			Mean	Max	LEL	UEL					
2,4,6-Trichlorophenol	37	0%	10,500	310,000	--	--				x	
2,4-Dichlorophenol	37	3%	10,500	310,000	--	--				x	
2,4-Dimethylphenol	37	0%	10,500	310,000	--	--				x	
2,4-Dinitrophenol	37	0%	50,600	1,500,000	--	--				x	
2,4-Dinitrotoluene	37	0%	10,500	310,000	--	--				x	
2,6-Dinitrotoluene	37	0%	10,500	310,000	--	--				x	
2-Chloronaphthalene	37	0%	10,500	310,000	--	--				x	
2-Chlorophenol	37	0%	10,500	310,000	--	--				x	
2-Methylnaphthalene	37	76%	**45,300**	**1,600,000**	70	--	x		x		**x**
2-Methylphenol	37	0%	**10,500**	**310,000**	--	12				x	
2-Nitroaniline	37	0%	50,600	1,500,000	--	--				x	
2-Nitrophenol	37	0%	10,500	310,000	--	--				x	
3,3'-Dichlorobenzidine	37	0%	50,600	1,500,000	--	--				x	
3-Methylphenol & 4-Methylphenol	37	0%	10,500	310,000	--	--				x	
3-Nitroaniline	37	0%	50,600	1,500,000	--	--				x	
4,6-Dinitro-2-methylphenol	37	0%	50,600	1,500,000	--	--				x	
4-Bromophenyl-phenylether	37	0%	**10,500**	**310,000**	--	1,200		x		x	
4-Chloro-3-Methylphenol	37	0%	10,500	310,000	--	--				x	
4-Chloroaniline	37	3%	10,400	310,000	--	--				x	
4-Chlorophenyl-phenylether	37	0%	10,500	310,000	--	--		x		x	
4-Nitroaniline	37	0%	50,600	1,500,000	--	--				x	
4-Nitrophenol	37	0%	50,600	1,500,000	--	--				x	
Acenaphthene	37	92%	**115,000**	**4,000,000**	16	500	x	x	x		**x**
Acenaphthylene	37	89%	**15,000**	**460,000**	44	640	x	x	x		**x**
Anthracene	37	92%	**116,000**	**4,000,000**	85	1,100	x	x	x		**x**
Benzo(a)anthracene	37	100%	**84,300**	**2,700,000**	261	1,600	x	x	x		**x**
Benzo(a)pyrene	37	100%	**65,700**	**2,100,000**	430	1,600	x	x	x		**x**
Benzo(b)fluoranthene	37	97%	**74,800**	**2,400,000**	--	4,000	x	x		x	**x**
Benzo(g,h,i)perylene	37	95%	**22,000**	**660,000**	170	320,000	x	x	x		**x**
Benzo(k)fluoranthene	37	92%	**28,600**	**920,000**	240	1,340,000	x	x	x		**x**
bis(2-Chloroethoxy)methane	37	0%	10,500	310,000	--	--				x	
bis(2-Chloroethyl)ether	37	0%	10,500	310,000	--	--				x	
bis(2-Ethylhexyl)phthalate	37	65%	**10,600**	**310,000**	--	2,700	x			x	**x**
Butylbenzylphthalate	37	16%	10,500	310,000	--	--	x			x	**x**

TABLE 6-6
SCREENING EVALUATION OF IN-RIVER SURFACE (0-0.5') SEDIMENT SAMPLES

Constituent	N	DF	Sediment Concentrations		Screening Criteria		DF > 10%	USEPA IBC	Max > LEL	No LEL	COPEC?
			Mean	Max	LEL	UEL					
Carbazole	37	49%	10,700	370,000	--	--	x			x	**x**
Chrysene	37	100%	**66,800**	**2,100,000**	384	2,800	x	x	x		**x**
Dibenzo(a,h)anthracene	37	84%	**7,200**	**220,000**	63	260	x	x	x		**x**
Dibenzofuran	37	73%	**55,300**	**2,000,000**	--	420	x			x	**x**
Diethylphthalate	37	0%	**10,500**	**310,000**	--	610				x	
Dimethylphthalate	37	0%	10,500	310,000	--	--				x	
Di-n-Butylphthalate	37	0%	10,500	**310,000**	--	240,000				x	
Di-n-Octylphthalate	37	0%	10,500	310,000	--	--				x	
Fluoranthene	37	100%	**296,000**	**10,000,000**	600	5,100	x	x	x		**x**
Fluorene	37	76%	**84,400**	**3,000,000**	19	540	x	x	x		**x**
Hexachlorobenzene	37	3%	**10,500**	**310,000**	20	24,000		x	x		
Hexachlorobutadiene	37	0%	**10,500**	**310,000**	20	--		x	x		
Hexachlorocyclopentadiene	37	0%	50,600	1,500,000	--	--		x		x	
Hexachloroethane	37	0%	**10,500**	**310,000**	--	1,000		x		x	
Indeno(1,2,3-cd)pyrene	37	92%	**23,400**	**720,000**	200	320,000	x	x	x		**x**
Isophorone	37	0%	10,500	310,000	--	--				x	
Naphthalene	37	84%	**92,600**	**3,200,000**	160	2,100	x		x		**x**
Nitrobenzene	37	0%	10,500	310,000	--	--				x	
N-Nitroso-di-n-propylamine	37	0%	10,500	310,000	--	--				x	
N-Nitrosodiphenylamine	37	0%	10,500	310,000	--	--				x	
Pentachlorophenol	37	0%	50,600	1,500,000	--	--		x		x	
Phenanthrene	37	97%	**392,000**	**14,000,000**	240	1,500	x	x	x		**x**
Phenol	37	0%	**10,500**	**310,000**	--	32				x	
Pyrene	37	100%	**146,000**	**4,700,000**	665	2,600	x	x	x		**x**
Total HMW PAHs	37	100%	**815,000**	**26,500,000**	--	4,354	x			x	**x**
Total LMW PAHs	37	97%	**861,000**	**30,300,000**	--	3,369	x			x	**x**
Total PAHs	37	100%	**1,680,000**	**56,800,000**	4,000	45,000	x		x		**x**
VOCs (µg/kg)											
1,1,1-Trichloroethane	37	0%	7.15	84	--	9,600				x	
1,1,2,2-Tetrachloroethane	37	0%	7.15	84	--	5,400				x	
1,1,2-Trichloroethane	37	0%	7.15	84	--	9,800				x	
1,1-Dichloroethane	37	0%	7.15	**84**	--	27				x	
1,1-Dichloroethene	37	0%	7.15	84	--	3,500				x	
1,2-Dichloroethane	37	0%	7.15	84	--	4,300				x	

TABLE 6-6
SCREENING EVALUATION OF IN-RIVER SURFACE (0-0.5') SEDIMENT SAMPLES

Constituent	N	DF	Sediment Concentrations		Screening Criteria		DF > 10%	USEPA IBC	Max > LEL	No LEL	COPEC?
			Mean	Max	LEL	UEL					
1,2-Dichloroethene (total)	37	0%	7.15	84	--	400				x	
1,2-Dichloropropane	37	0%	7.15	84	--	--				x	
2-Butanone	37	24%	11.6	84	--	270	x			x	**x**
2-Hexanone	37	0%	7.15	**84**	--	23				x	
4-Methyl-2-pentanone	37	0%	7.15	84	--	15,000				x	
Acetone	37	38%	**33**	**341**	--	9.1	x			x	**x**
Benzene	37	5%	42.5	**1,300**	340	160			x		
Bromodichloromethane	37	0%	7.15	84	--	--				x	
Bromoform	37	0%	7.15	84	--	--				x	
Bromomethane	37	0%	7.15	84	--	--				x	
Carbon Disulfide	37	11%	**6.89**	**84**	--	0.86	x			x	**x**
Carbon Tetrachloride	37	0%	7.15	84	--	2,000				x	
Chlorobenzene	37	3%	7.1	84	--	417				x	
Chloroethane	37	0%	7.15	84	--	--				x	
Chloroform	37	3%	6.95	84	--	960				x	
Chloromethane	37	0%	7.15	84	--	--				x	
cis-1,3-Dichloropropene	37	0%	7.15	84	--	--				x	
Dibromochloromethane	37	0%	7.15	84	--	--				x	
Ethylbenzene	37	11%	153	**5,300**	1,400	5,400	x		x		**x**
Methylene Chloride	37	0%	5.86	83.2	--	18,000				x	
Styrene	37	0%	7.15	84	--	--				x	
Tetrachloroethene	37	0%	7.15	84	450	3,200					
Toluene	37	24%	8.21	**84**	2,500	50	x				
Total BTEX	37	30%	207	6820	--	--	x			x	**x**
trans-1,3-Dichloropropene	37	0%	7.15	84	--	--				x	
Trichloroethene	37	0%	7.15	84	1,600	52,000					

TABLE 6-6
SCREENING EVALUATION OF IN-RIVER SURFACE (0-0.5') SEDIMENT SAMPLES

Constituent	N	DF	Sediment Concentrations		Screening Criteria		DF > 10%	USEPA IBC	Max > LEL	No LEL	COPEC?
			Mean	Max	LEL	UEL					
Vinyl Chloride	37	0%	7.15	84	--	--				x	
Xylenes (total)	37	8%	24	**200**	120	160			x		

Notes:
1. N - Sample number
2. DF - Detection Frequency
3. LEL - Lower Effects Level
4. UEL - Upper Effects Level
5. "--" - No Criteria Available
6. IBC - Important Bioaccumulative Compound, as described by USEPA (2000)
7. COPEC - Constituent of Potential Ecological Concern
8. TCDD - 2,3,7,8-Tetrachlorodibenzo-p-dioxin
9. TCDF - 2,3,7,8-Tetrachlordibenzofuran
10. TEQ - Toxic Equivalent
11. WHO - World Health Organization
12. PCB - Polychlorinated Biphenyl
13. SVOC - Semi-Volatile Organic Compound
14. USEPA - United States Environmental Protection Agency
15. VOC - Volatile Organic Compound
16. mg/kg - milligrams per kilogram
17. pg/g - picograms per gram
18. µg/kg - micrograms per kilogram
19. Mean values were calculated using one-half the detection limit for non-detects
20. Field and duplicate sample results were averaged together to create one result
21. WHO TEQs were calculated using 1/2 of the detection limit for non-detects, according to the method described in Van den Berg et al. (2006)

COPEC Selection Decision Criteria:
1 - Detection Frequency < 10% → Not Retained as a COPEC
2 - USEPA IBC → Retained as COPEC
3 - Maximum Concentration > LEL → Retained as a COPEC
4 - No LEL Available → Retained as a COPEC
5 - Does Not Meet Criteria 2,3, or 4 → Not Retained as a COPEC

- Concentration exceeds LEL

- Concentration exceeds UEL

TABLE 6-7
SUMMARY OF HACKENSACK RIVER STUDY AREA SEDIMENT COPECs

Constituent	In-River Surface Sediment	Mudflat Surface Sediment	All Surface Sediment
Inorganics (mg/kg)			
Aluminum	x	x	x
Arsenic	x	x	x
Barium	x	x	x
Beryllium	x	x	x
Cadmium	x	x	x
Chromium (Total)	x	x	x
Chromium (Hexavalent)	x	x	x
Cobalt	x	x	x
Copper	x	x	x
Cyanide	x	x	x
Iron	x	x	x
Lead	x	x	x
Manganese	x	x	x
Mercury	x	x	x
Nickel	x	x	x
Selenium	x	x	x
Silver	x	x	x
Vanadium	x	x	x
Zinc	x	x	x
Dioxins/Furans (pg/g)			
WHO Dioxin TEQ (Birds)	x	x	x
WHO Dioxin TEQ (Fish)	x	x	x
WHO Dioxin TEQ (Human/Mammal)	x	x	x
PCBs (pg/g)			
Total Aroclor PCBs	x	x	x
Total Homolog Groups	x	x	x
Total PCB	x	x	x
WHO PCB Congener TEQ (Birds)	x	x	x
WHO PCB Congener TEQ (Fish)	x	x	x
WHO PCB Congener TEQ (Human/Mammal)	x	x	x

TABLE 6-7
SUMMARY OF HACKENSACK RIVER STUDY AREA SEDIMENT COPECs

Constituent	In-River Surface Sediment	Mudflat Surface Sediment	All Surface Sediment
Pesticides & Herbicides (µg/g)			
4,4'-DDD	x	x	x
4,4'-DDE	x	x	x
4,4'-DDT	x	x	x
Total DDT	x	x	x
Aldrin	x	x	x
Alpha-BHC	x	x	x
Alpha-Chlordane	x	x	x
Beta-BHC		x	
Delta-BHC	x	x	x
Dieldrin	x	x	x
Endosulfan I	x		x
Endosulfan II	x	x	x
Endrin	x	x	x
Endrin Aldehyde	x	x	x
Endrin Ketone	x	x	x
Gamma-Chlordane	x	x	x
Heptachlor	x		
Heptachlor Epoxide	x	x	x
SVOCs (µg/g)			
1,2,4-Trichlorobenzene	x	x	x
1,2-Dichlorobenzene	x	x	x
1,3-Dichlorobenzene	x	x	x
1,4-Dichlorobenzene	x	x	x
2-Methylnaphthalene	x	x	x
4-Chloroaniline		x	
Acenaphthene	x	x	x
Acenaphthylene	x	x	x
Anthracene	x	x	x
Benzo(a)anthracene	x	x	x
Benzo(a)pyrene	x	x	x
Benzo(b)fluoranthene	x	x	x

TABLE 6-7
SUMMARY OF HACKENSACK RIVER STUDY AREA SEDIMENT COPECs

Constituent	In-River Surface Sediment	Mudflat Surface Sediment	All Surface Sediment
Benzo(g,h,i)perylene	x	x	x
Benzo(k)fluoranthene	x	x	x
bis(2-Ethylhexyl)phthalate	x	x	x
Butylbenzylphthalate	x	x	x
Carbazole	x	x	x
Chrysene	x	x	x
Dibenzo(a,h)anthracene	x	x	x
Dibenzofuran	x	x	x
Fluoranthene	x	x	x
Fluorene	x	x	x
Indeno(1,2,3-cd)pyrene	x	x	x
Naphthalene	x	x	x
Phenanthrene	x	x	x
Pyrene	x	x	x
Total HMW PAHs	x	x	x
Total LMW PAHs	x	x	x
Total PAHs	x	x	x
VOCs (µg/g)			
2-Butanone	x	x	x
Acetone	x	x	x
Carbon Disulfide	x		
Chlorobenzene		x	

TABLE 6-7
SUMMARY OF HACKENSACK RIVER STUDY AREA SEDIMENT COPECs

Constituent	In-River Surface Sediment	Mudflat Surface Sediment	All Surface Sediment
Ethylbenzene	x		
Total BTEX	x		x

Notes:
1. COPEC - Constituent of Potential Ecological Concern
2. TCDD - 2,3,7,8-Tetrachlorodibenzo-p-dioxin
3. TCDF - 2,3,7,8-Tetrachlordibenzofuran
4. TEQ - Toxic Equivalent
5. WHO - World Health Organization
6. PCB - Polychlorinated Biphenyl
7. SVOC - Semi-Volatile Organic Compound
8. VOC - Volatile Organic Compound
9. Only constituents that were selected as COPECs for at least one area are shown
10. mg/kg - milligrams per kilogram
11. pg/g - picograms per gram
12. µg/kg - micrograms per kilogram

TABLE 6-8
SUMMARY RESULTS FOR AVS/SEM IN HRSA

Geomorphic Unit	SEM_T/AVS (unitless)				Range of (SEM_T-AVS)/foc (umol/g-oc)		
	Range	*< 1*	*>1*	*Range*	*< 130*	*130-3000*	*> 3000*
Center Channel	0.028 - 7	7/20	13/20	-3944 - 4272	13/20	6/20	1/20
Mudflat 1	7.4 - 26.3	0/3	3/3	92 - 933	1/3	2/3	0/3
Mudflat 2	0.13 - 5.6	2/3	1/3	-824 - 92	3/3	0/3	0/3
Mudflat 4	0.44 - 7.6	2/3	1/3	-116 - 56	3/3	0/3	0/3
Mudflat 6	0.035 - 0.36	3/3	0/3	-2996 - -245	3/3	0/3	0/3
Mudflat 9	0.19 - 1.2	2/3	1/3	-361 - 1.6	3/3	0/3	0/3
Mudflat 10	0.14 - 5	3/4	1/3	-446 - 78	4/4	0/4	0/4
Side Channel	0.1 - 2.2	13/17	4/17	-990 - 1009	15/17	2/17	0/17

Notes:

1. umoles/g = micromoles per gram of sediment
2. umoles/g-oc = micromoles per grams of organic carbon
3. AVS = acid volatile sulfide
4. SEM = simultaneously extracted metals
5. f_{oc} = fraction organic carbon
6. * SEM_T is calculated according to the USEPA (2002) as the molar sum of the concentrations of cadmium (Cd), copper (Cu), lead (Pb), mercury (Hg), nickel (Ni), silver (Ag), and zinc (Zn), extracted simultaneously with AVS. Half the concentration of Ag is used to account for the fact that it is monovalent.
7. ^ If the ratio of SEM_T to AVS is less than or equal to 1, then the mixture of metals is less bioavailable and sediments may have limited acute and chronic toxicity to benthic organisms. Bolded values indicate an exceedance of this benchmark.
8. † (SEM_T-AVS)/f_{oc} represents the amount of SEM_T in excess of AVS normalized to organic carbon, where SEM_T was calculated according to the USEPA (2002) as the molar sum of the concentrations of Cd, Cu, Pb, Ni, Ag, and Zn, extracted simultaneously with AVS. Half the concentration of Ag is used to account for the fact that it is monovalent. The ratio provides a benchmark for potential acute toxicity to benthic organisms:
   (1) If (SEMT-AVS)/foc < 130 umol/g-oc, metals are less bioavailable and sediments may have limited toxicity due to Cd, Cu, Pb, Ni, or Zn.
   (2) If 130 umol/g-oc < (SEMT-AVS)/foc < 3000 umol/g-oc, metals are more bioavailable and sediment could potentially be toxic due to Cd, Cu, Pb, Ni, or Zn. (Bold values)
   (3) If (SEMT-AVS)/foc > 3000 umol/g-oc, metals are bioavailable and sediments are likely toxic due to Cd, Cu, Pb, Ni, or Zn. (Bold and shaded values)
   (4) Any sediment with AVS > 0 will not cause adverse biological effects due to Ag.

** Hidden columns contain SEM and SEM/AVS ratio in which SEM was calculated as the molar sum of Cd,Cu,Pb,Ni,(0.5*Ag),Zn, but NOT Hg

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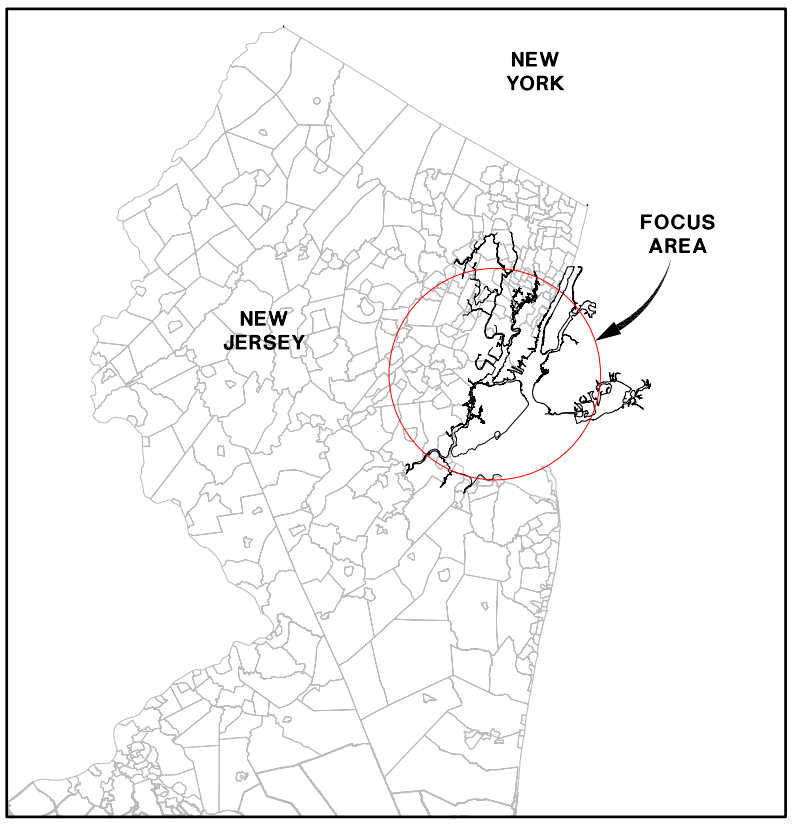

LOCATION MAP

DUNDEE DAM
SADDLE RIVER
THIRD RIVER
BERGEN COUNTY
BELLMAN'S CREEK
BERRY'S CREEK CANAL
BERRY'S CREEK
CROMAKILL CREEK
SECOND RIVER
KINGSLAND CREEK
FRANK'S CREEK
SAWMILL CREEK
HACKENSACK RIVER STUDY AREA
PASSAIC RIVER
LAWYER'S CREEK
HARRISON CREEK
HUDSON COUNTY
ESSEX COUNTY
PLUM CREEK
PIERSON'S CREEK
PORT NEWARK
PORT NEWARK CHANNEL
NEWARK BAY
NEWARK LIBERTY INTERNATIONAL AIRPORT
ELIZABETH CHANNEL
UNION COUNTY
PERIPHERAL DITCH
PORT ELIZABETH
SOUTH ELIZABETH CHANNEL
PLATYKILL CREEK
UPPER NEW YORK BAY
ARLINGTON MARSH
SHOOTERS ISLAND
ELIZABETH RIVER
KILL VAN KULL
MORSES CREEK
MARINERS MARSH
OLD PLACE CREEK
PILES CREEK
PRALLS ISLAND
RAHWAY RIVER
STATEN ISLAND
ARTHUR KILL
FRESH KILLS
MIDDLESEX COUNTY

NOTE:

1. BASEMAP INFORMATION FROM NOAA CHARTS 12331, 12333, AND 12337, DATED MAY 4, 1995.

km
miles
0 .5 1 1.5 2 2.5 3 4 5

PENINSULA RESTORATION GROUP

HACKENSACK RIVER STUDY AREA
REMEDIAL INVESTIGATION REPORT

NEW YORK/NEW JERSEY HARBOR ESTUARY REGIONAL MAP

ARCADIS BBL
Infrastructure, environment, facilities

FIGURE
1-1

SYR-85 MTK KEW
Tierra Hackensack (09987.012)
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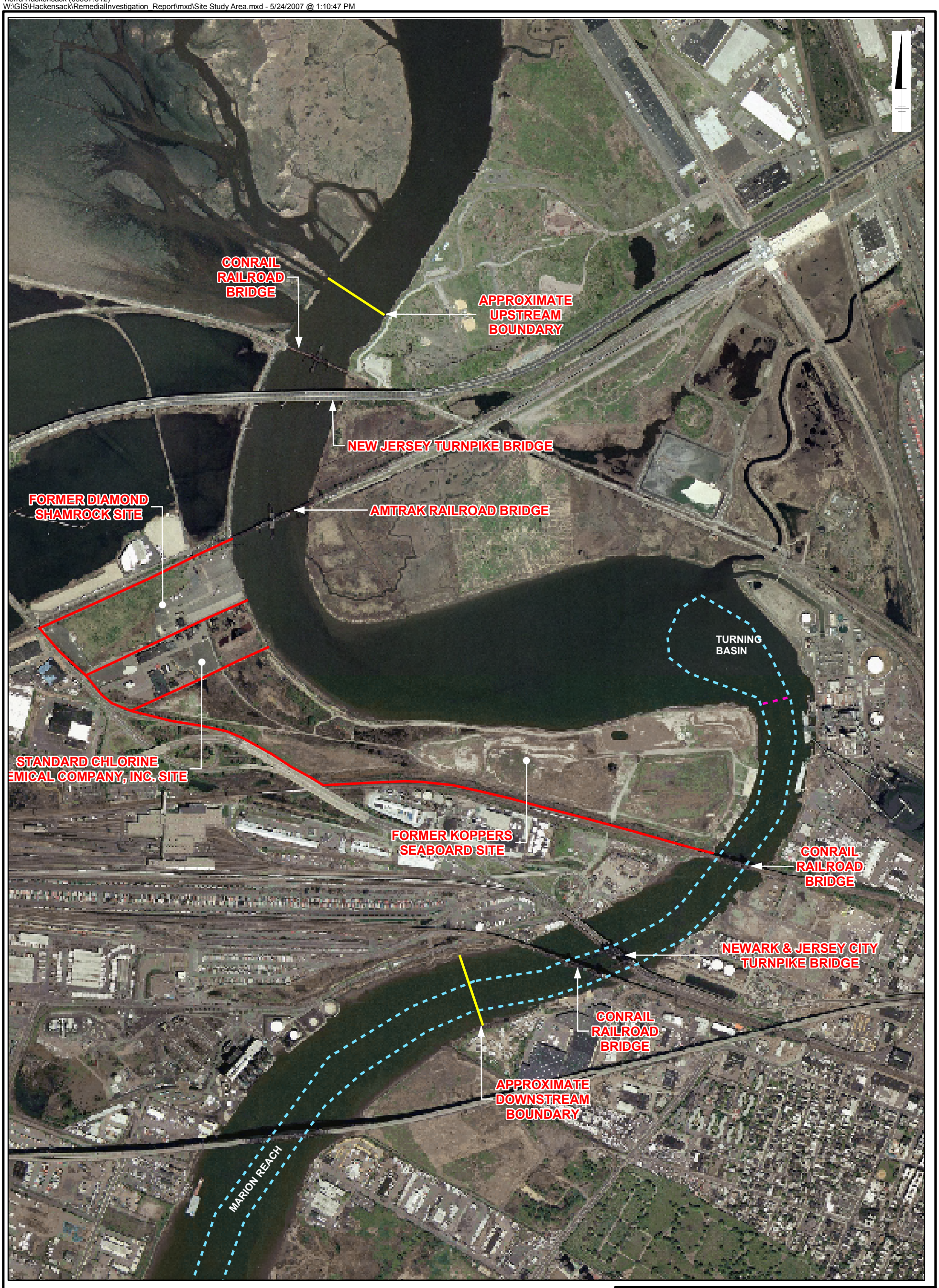

LEGEND:

- STUDY AREA BOUNDARY
- REACH BOUNDARY
- PROPERTY BOUNDARY
- NAVIGATION CHANNEL

NOTES:

1. AERIAL PHOTOS DATED MAY 2002 AND JULY 2002 (INTRASEARCH, ENGLEWOOD, CO).
2. NAVIGATION CHANNEL DIGITIZED FROM NAUTICAL CHARTS 12337 22nd ED., NOVEMBER 15, 1997 AND 12333 32nd ED., OCTOBER, 2002.

0 1,000 2,000 Feet

GRAPHIC SCALE

PENINSULA RESTORATION GROUP

HACKENSACK RIVER STUDY AREA REMEDIAL INVESTIGATION REPORT

HACKENSACK RIVER STUDY AREA

ARCADIS BBL
Infrastructure, environment, facilities

FIGURE 1-2

SYR-85 MTK KEW
Hackensack (09987.017)
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NOTES:

1. HORIZONTAL DATUM: NEW JERSEY STATE PLANE COORDINATE SYSTEM, NAD83.
2. AERIAL PHOTO DATED JULY 2002 (INTRASEARCH, ENGLEWOOD, CO).
3. MUDFLAT AND OUTFALL LOCATIONS WERE RECORDED DURING THE RECONNAISSANCE PROGRAM (MARCH/ APRIL 2005) USING DGPS. HOWEVER, ACTUAL LOCATIONS (RELATIVE TO THAT SHOWN ON THIS FIGURE) MAY VARY SLIGHTLY.
4. THE RECONNAISSANCE PROGRAM ONLY IDENTIFIED THE LENGTH OF A GIVEN MUDFLAT ALONG THE SHORELINE; ITS EXTENSION INTO THE RIVER WAS NOT MEASURED/DEFINED.

0 1,000 2,000 Feet

GRAPHICAL SCALE

PENINSULA RESTORATION GROUP

HACKENSACK RIVER STUDY AREA REMEDIAL INVESTIGATION REPORT

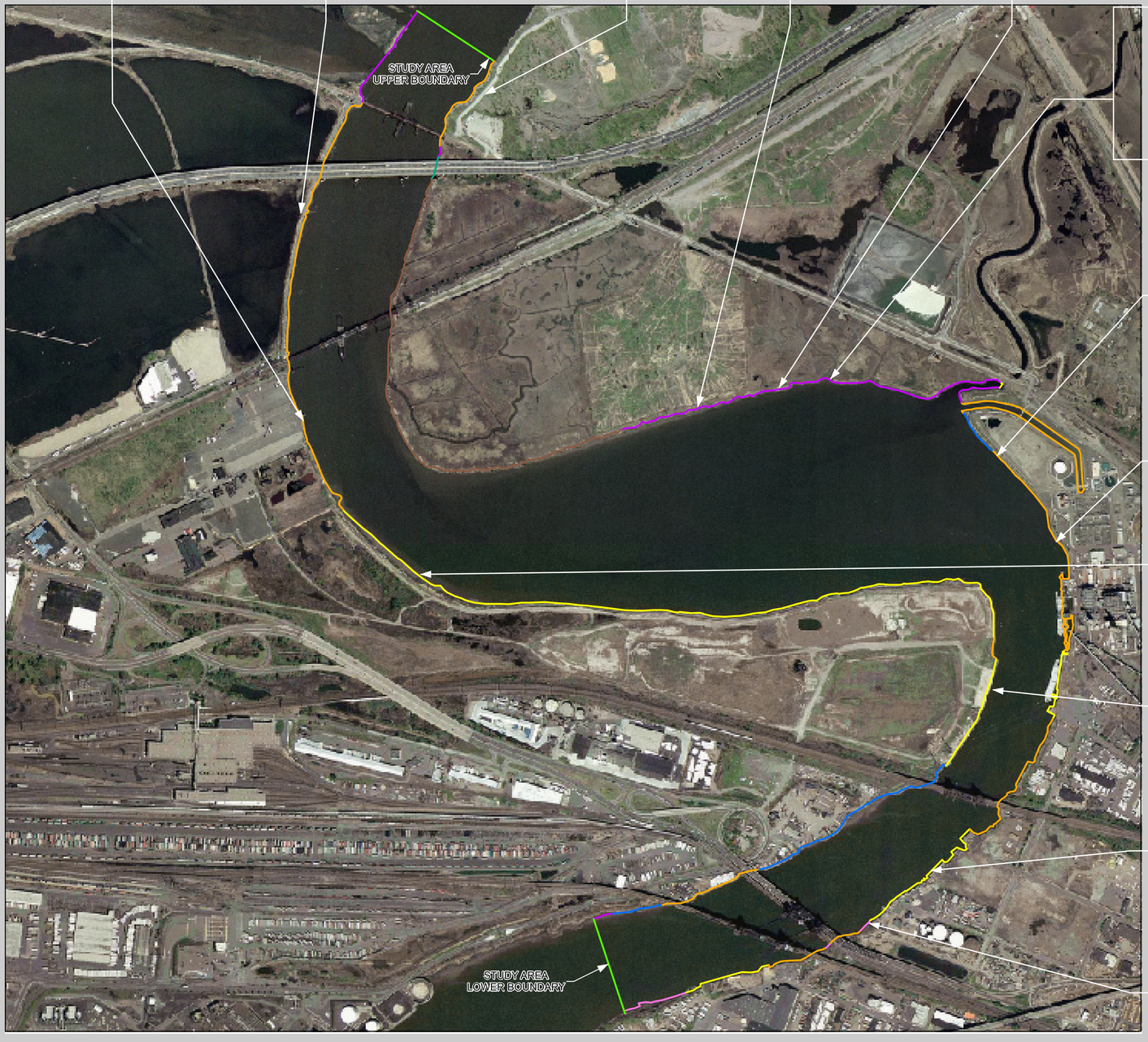
MUDFLAT, OUTFALL, AND TIDE GATE LOCATIONS

ARCADIS BBL
Infrastructure, environment, facilities

FIGURE 2-1














LEGEND:

HABITAT CLASSIFICATION

- VEGETATED - P. AUSTRALIS DOMINATED
- VEGETATED - P. AUSTRALIS DOMINATED AND RIPRAP
- VEGETATED - P. AUSTRALIS DOMINATED WITH S. ALTERNIFLORA FRINGE
- VEGETATED - OTHER
- VEGETATED - OTHER AND RIPRAP
- RIPRAP
- BULKHEAD

NOTES:

1. HORIZONTAL DATUM: NEW JERSEY STATE PLANE COORDINATE SYSTEM, NAD83.
2. AERIAL PHOTO DATED JULY 2002 (INTRASEARCH, ENGLEWOOD, CO).
3. HABITAT CLASSIFICATIONS AND SHORELINE TYPES WERE RECORDED USING DGPS. HOWEVER, ACTUAL LOCATIONS (RELATIVE TO THAT SHOWN ON THIS FIGURE) MAY VARY SLIGHTLY.

0 500 1,000 Feet

GRAPHIC SCALE

PENINSULA RESTORATION GROUP

HACKENSACK RIVER STUDY AREA REMEDIAL INVESTIGATION REPORT

HABITAT LOCATIONS AND SELECT PHOTOGRAPHS

ARCADIS BBL
Infrastructure, environment, facilities

FIGURE
2-2

SYR-85 MTK KEW
Hackensack (09987.017)
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SYR-85 KEW MTK KEW
Hackensack (09987.017)
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LEGEND:
- FINAL CORING LOCATION
- RECONNAISSANCE PROGRAM SEDIMENT PROBING TRANSECT
- MUDFLAT
- MUDFLAT CHOSEN FOR SAMPLING
- HACKENSACK RIVER STUDY AREA BOUNDARY
- HACKENSACK RIVER SHORELINE
- HACKENSACK RIVER CENTERLINE (USEPA)
- -5.5- HACKENSACK RIVER MILE
- * CORING LOCATION MOVED FOR UTILITY CLEARANCE

NOTES:
1. HORIZONTAL DATUM: NEW JERSEY STATE PLANE COORDINATE SYSTEM, NAD83.
2. RIVER OUTLINE DIGITIZED FROM AERIAL PHOTOGRAPHS DATED MAY 2002 AND JULY 2002 (INTRASEARCH, ENGLEWOOD, CO).

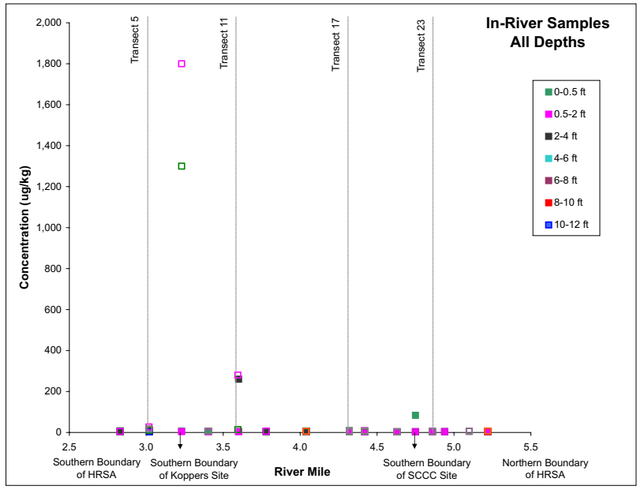
0 1,000 2,000 Feet
GRAPHIC SCALE

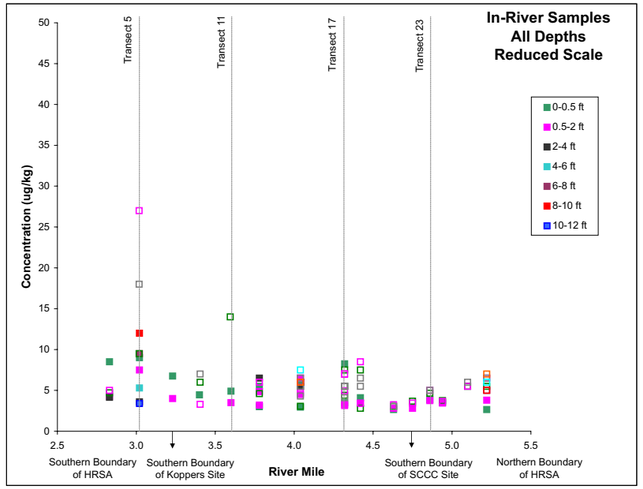
PENINSULA RESTORATION GROUP
HACKENSACK RIVER STUDY AREA REMEDIAL INVESTIGATION REPORT

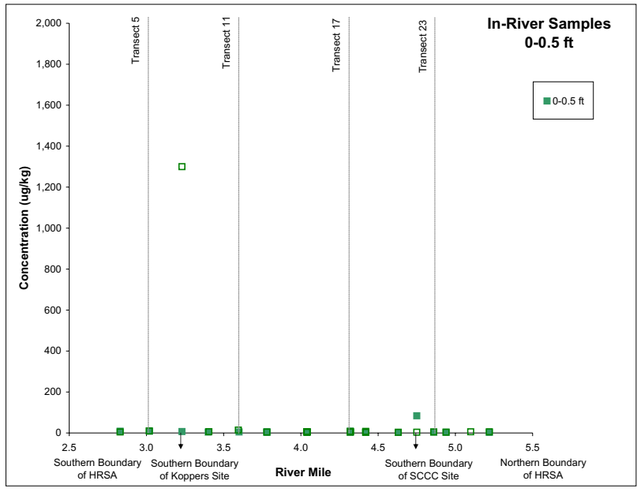
FINAL CORING LOCATIONS

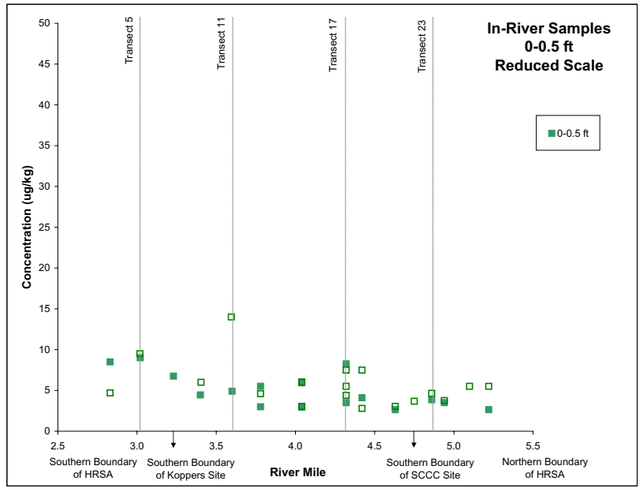
ARCADIS BBL
Infrastructure, environment, facilities

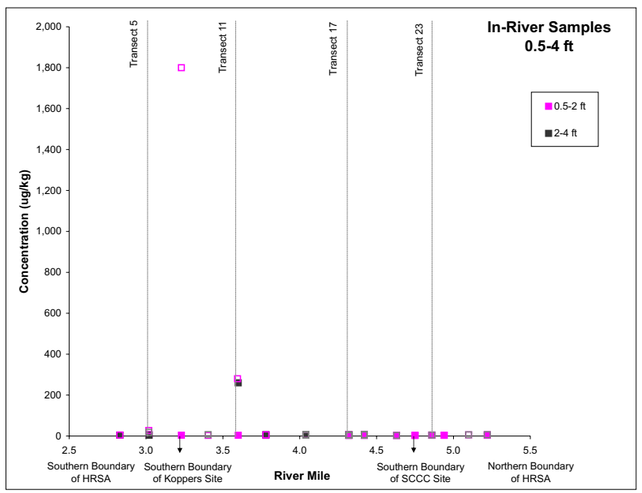
FIGURE 3-1

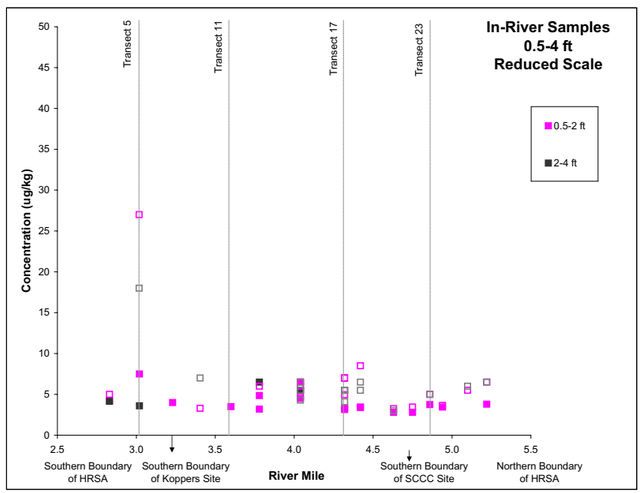












Notes:

1. Filled symbols represent results from the western side of the Hackensack River.
2. Open symbols represent results from the eastern side of the Hackensack River.
3. Reduced scale charts shown to provide more detail at lower concentrations. Certain analytical results showing relatively higher concentrations may be omitted for presentation purposes only.
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7. ug/kg – micrograms per kilogram

PENINSULA RESTORATION GROUP
HACKENSACK RIVER STUDY AREA
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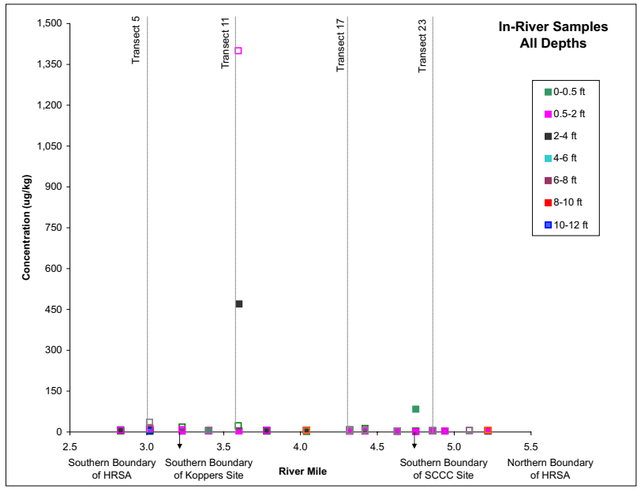
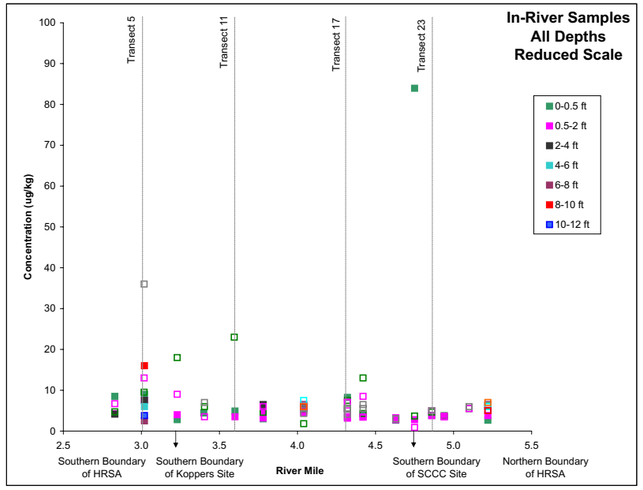
CONCENTRATION VS. RIVER MILE BENZENE

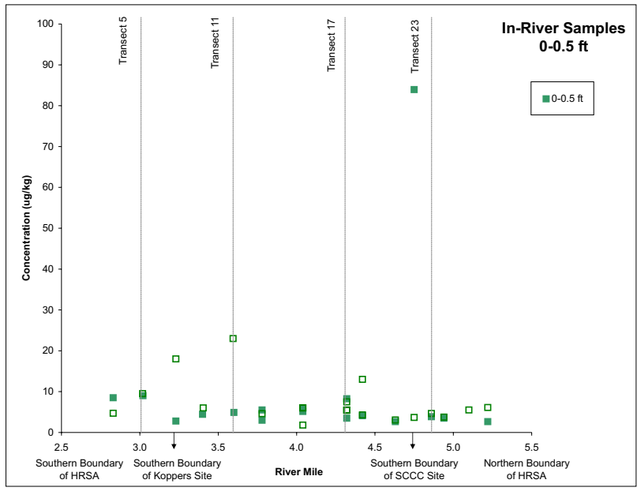
ARCADIS BBL
Infrastructure, environment, facilities

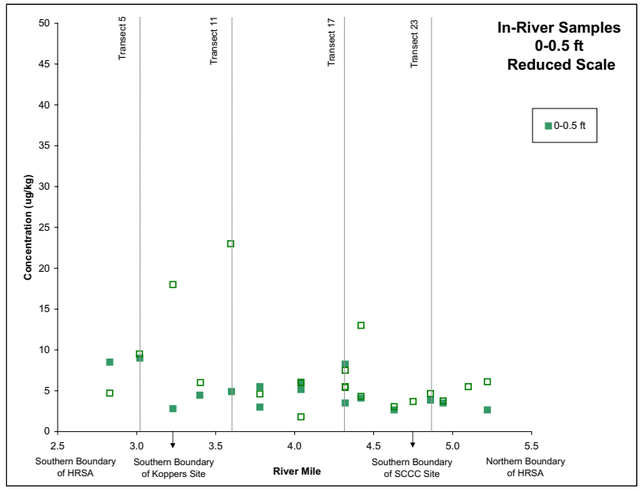
FIGURE 5-1

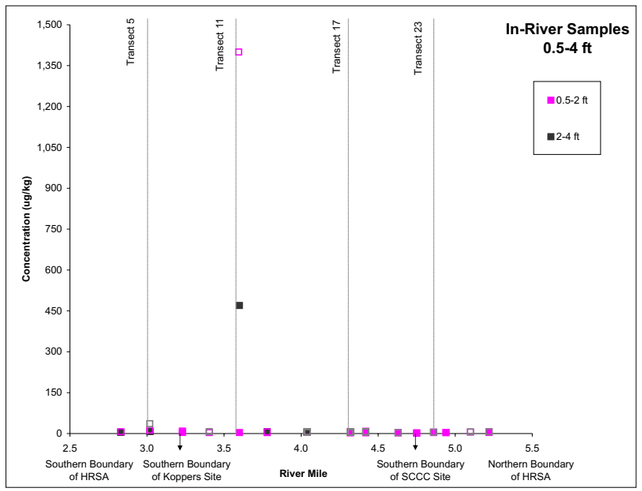
05/09/07 SYR-D85-DJH
09987015/09987G15.CDR

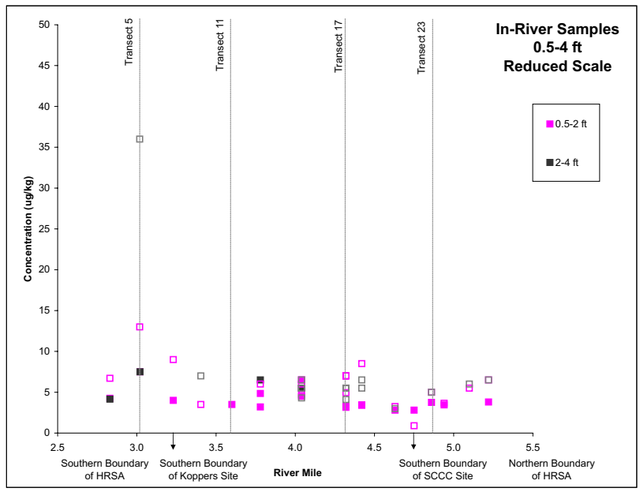












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PENINSULA RESTORATION GROUP
HACKENSACK RIVER STUDY AREA

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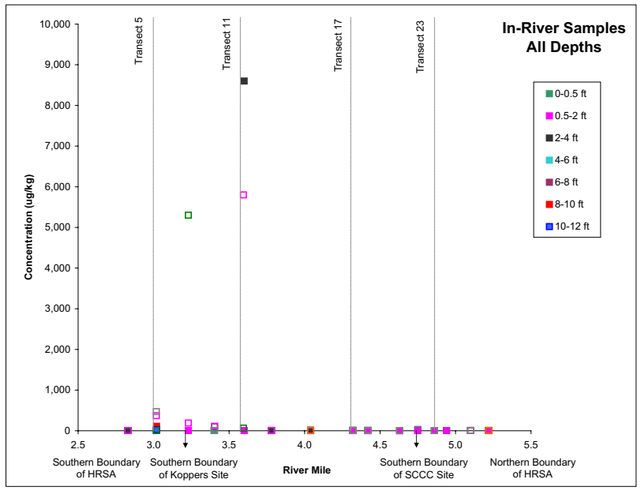
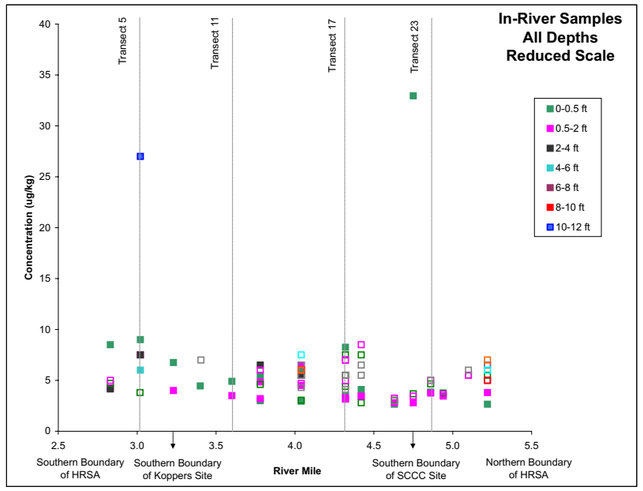
CONCENTRATION VS. RIVER MILE TOLUENE

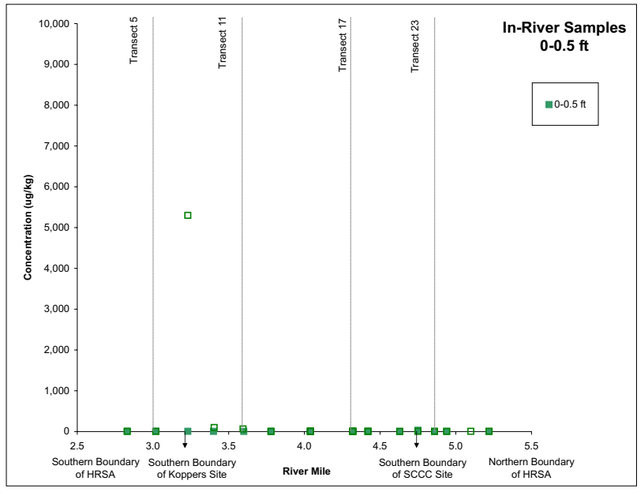
ARCADIS BBL
Infrastructure, environment, facilities

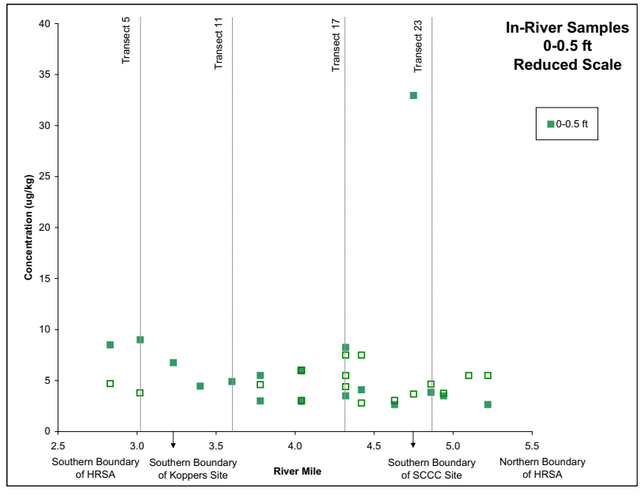
FIGURE 5-2

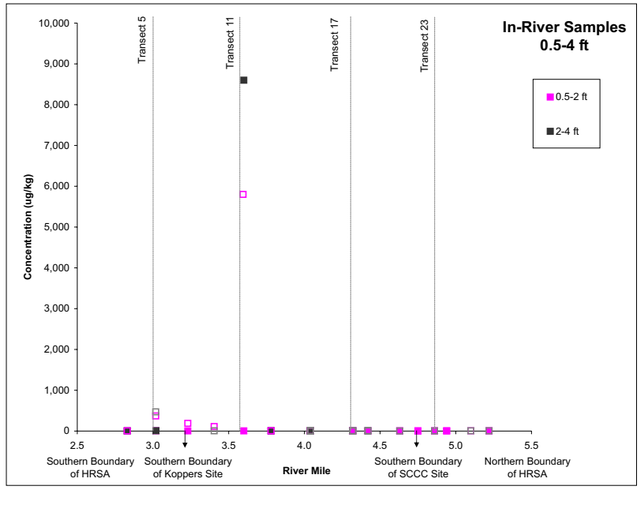
05/30/07 SYR-D85-DJH
09987015/09987G16.CDR

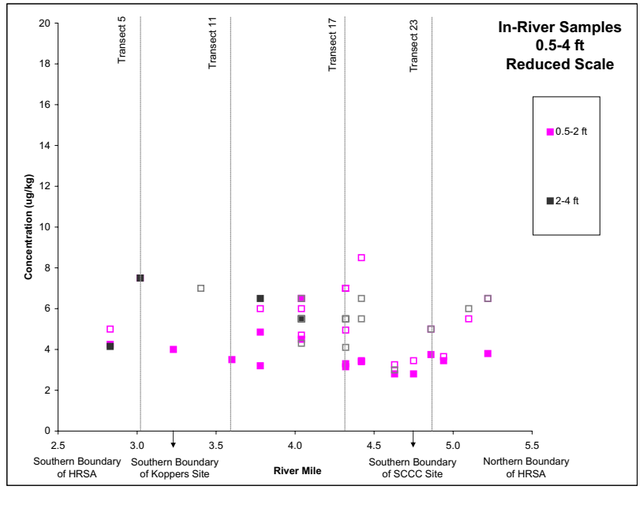












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PENINSULA RESTORATION GROUP
HACKENSACK RIVER STUDY AREA
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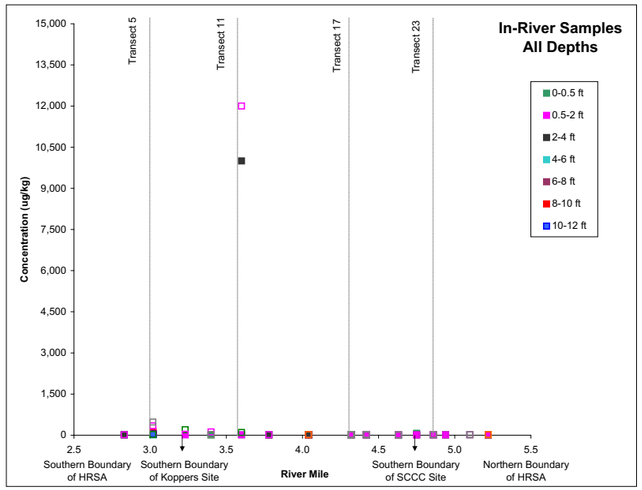
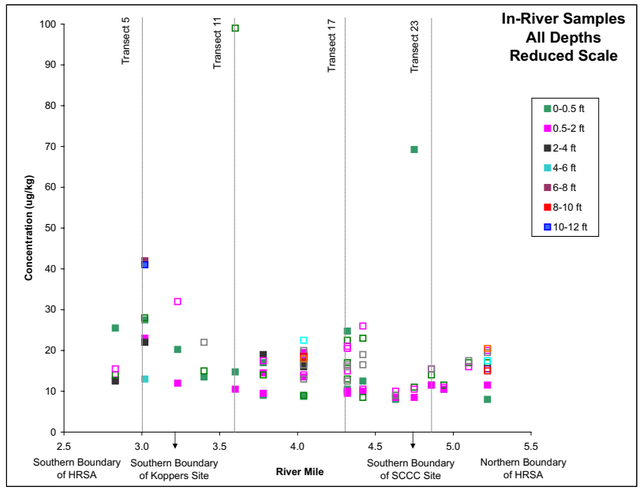
CONCENTRATION VS. RIVER MILE ETHYLBENZENE

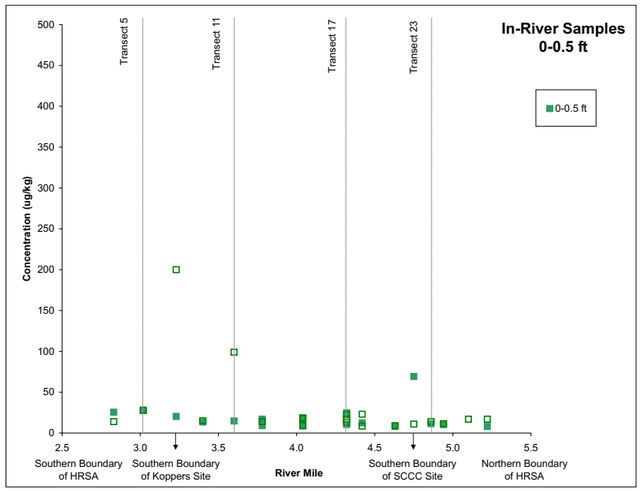
ARCADIS BBL
Infrastructure, environment, facilities

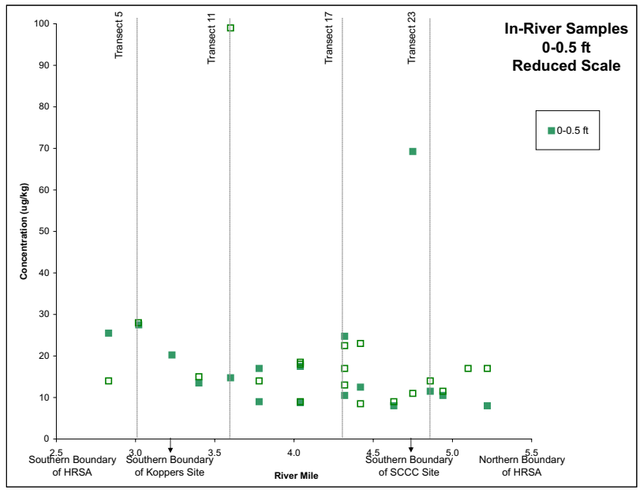
FIGURE 5-3

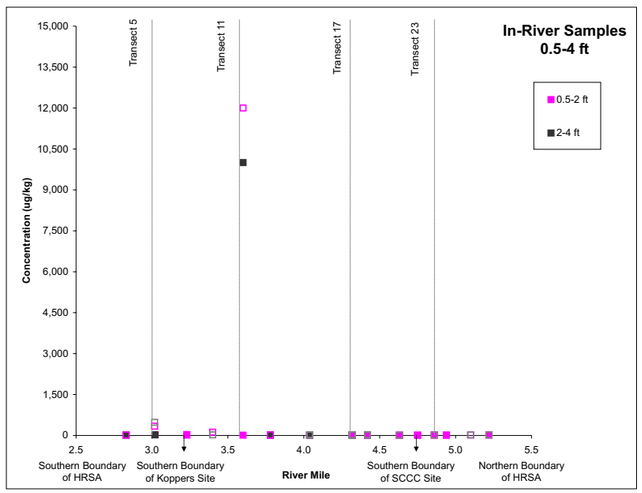
05/30/07 SYR-D85-DJH
09987015/09987G17.CDR

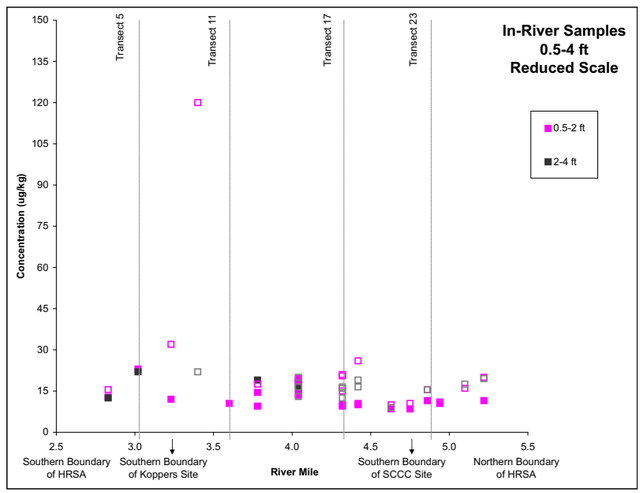












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PENINSULA RESTORATION GROUP
HACKENSACK RIVER STUDY AREA

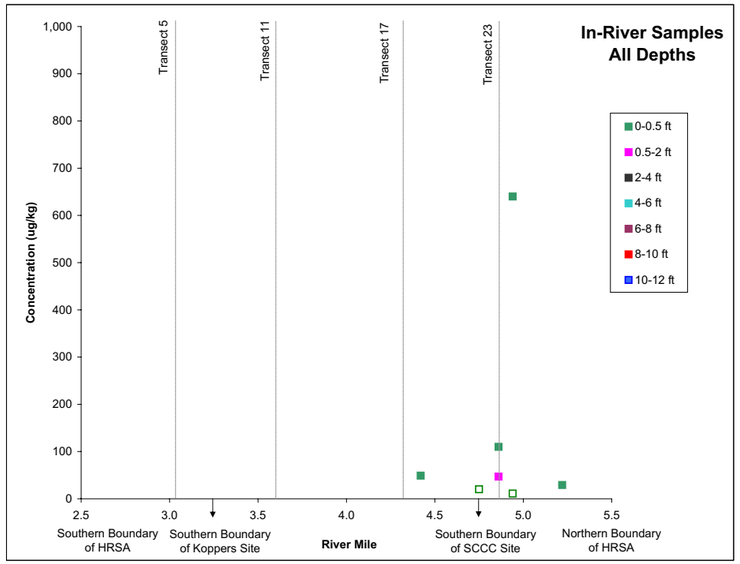
REMEDIAL INVESTIGATION REPORT

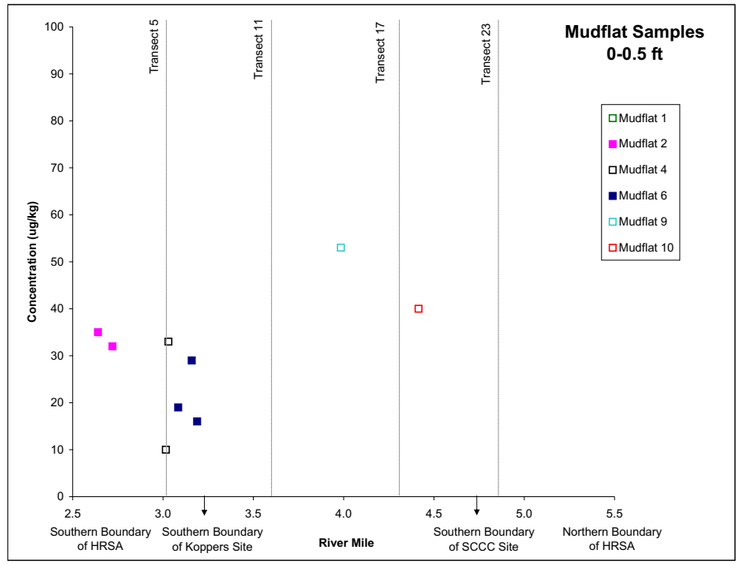
CONCENTRATION VS. RIVER MILE XYLENE

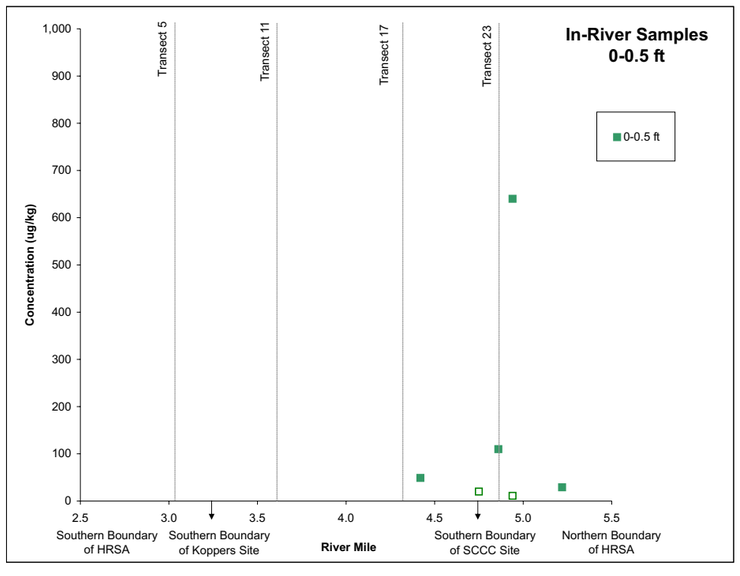
ARCADIS BBL
Infrastructure, environment, facilities

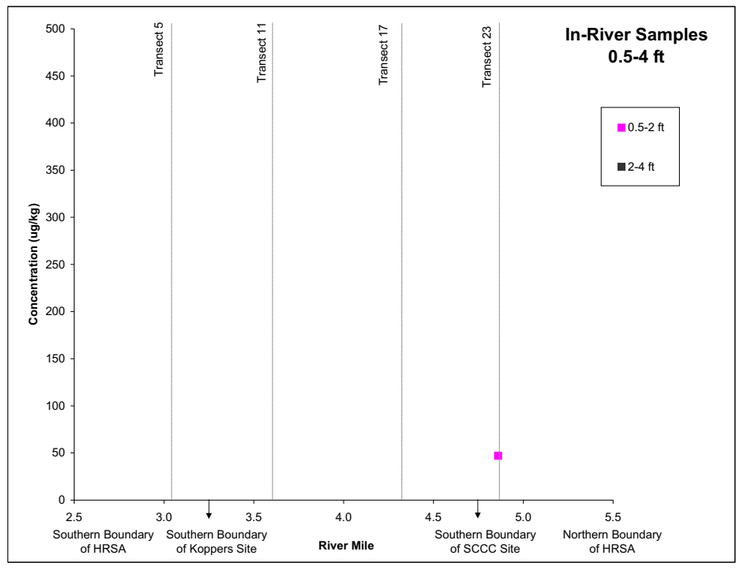
FIGURE 5-4

05/30/07 SYR-D85-DJH
09987015/09987G18.CDR









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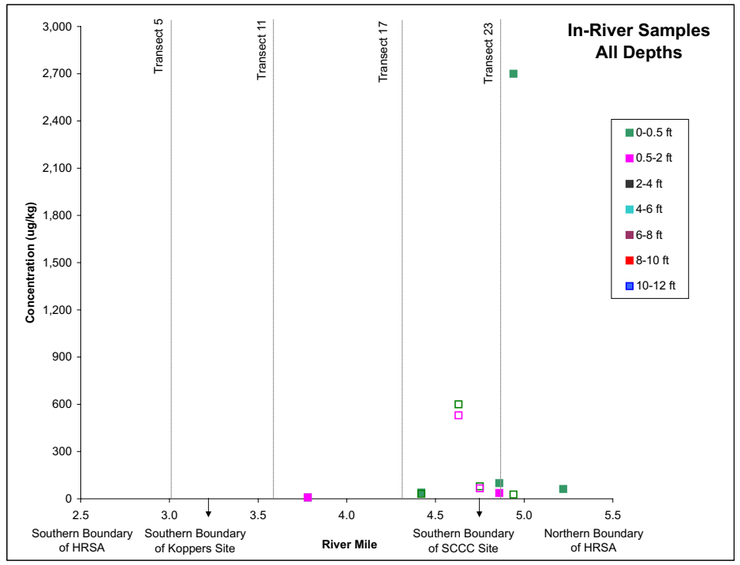
PENINSULA RESTORATION GROUP
HACKENSACK RIVER STUDY AREA
REMEDIAL INVESTIGATION REPORT

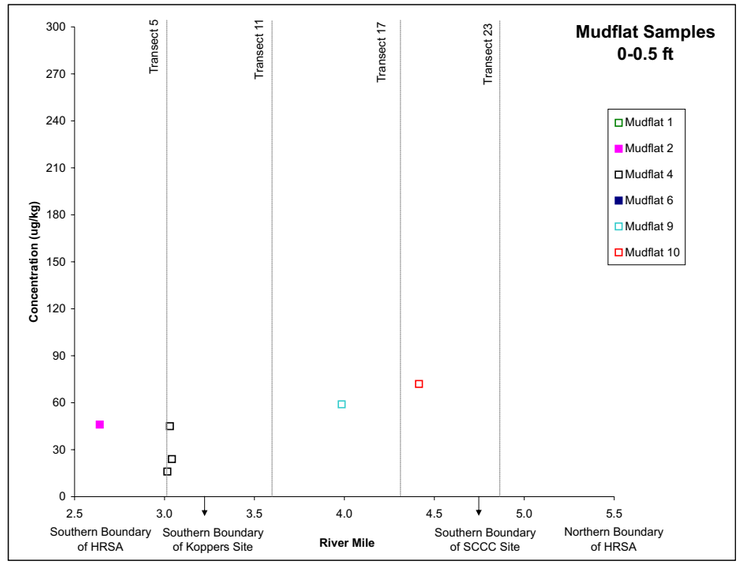
CONCENTRATION VS. RIVER MILE
1,2-DICHLOROBENZENE

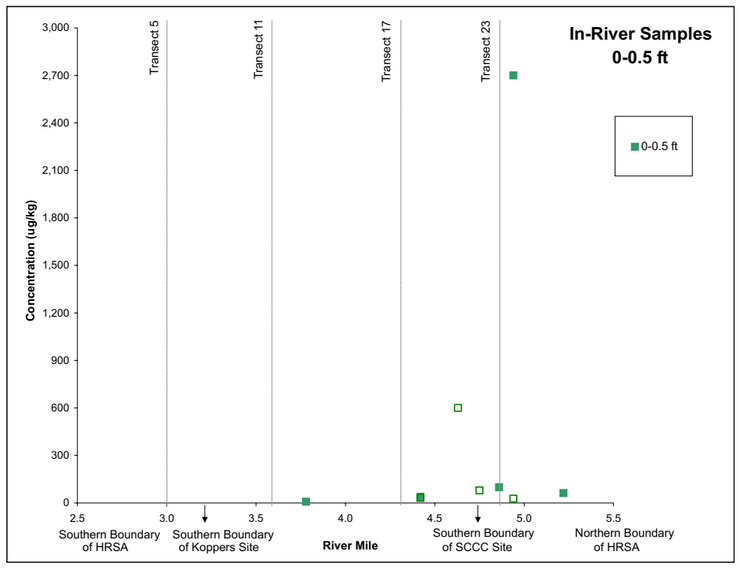
ARCADIS BBL
Infrastructure, environment, facilities

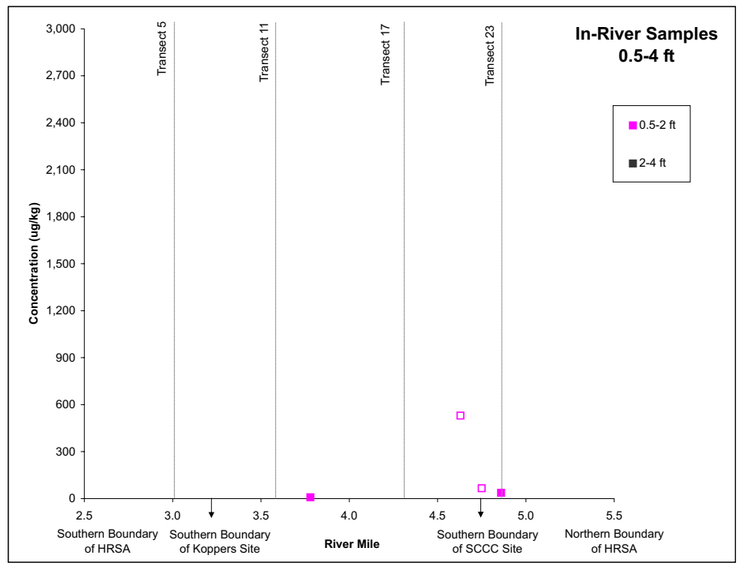
FIGURE
5-5

05/30/07 SYR-D85-DJH
09987015/09987G24.CDR









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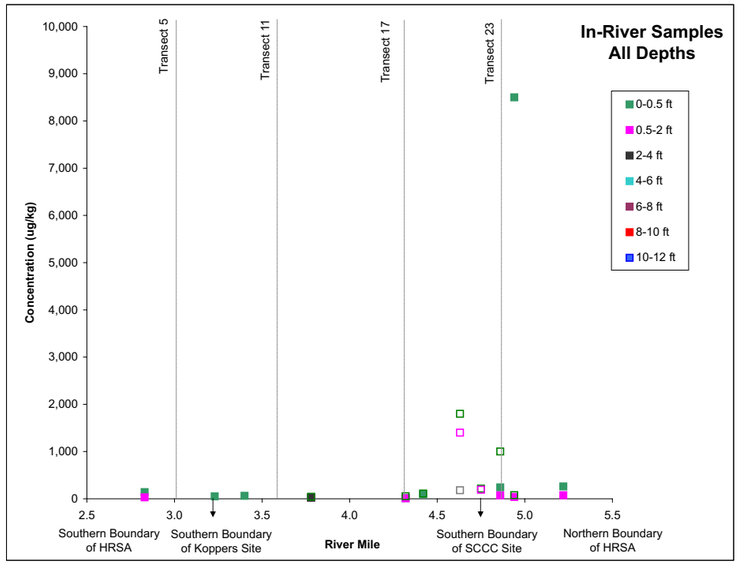
PENINSULA RESTORATION GROUP
HACKENSACK RIVER STUDY AREA
REMEDIAL INVESTIGATION REPORT

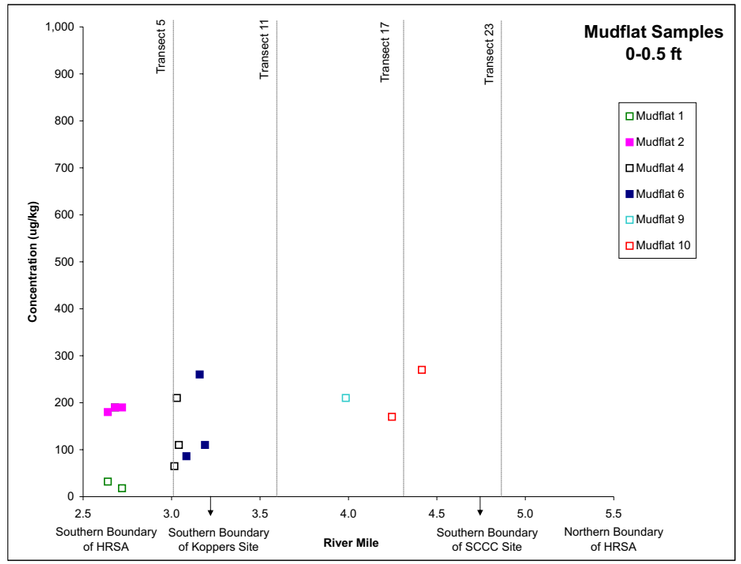
CONCENTRATION VS. RIVER MILE
1,3-DICHLOROBENZENE

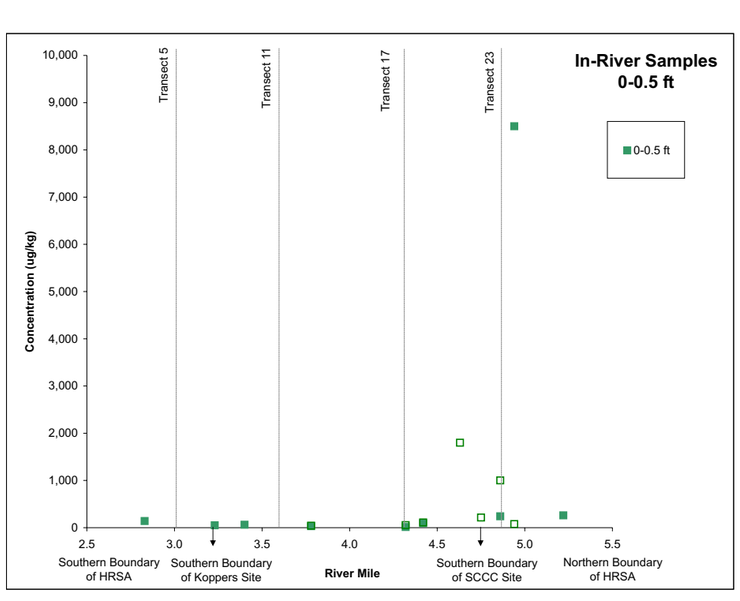
ARCADIS BBL
Infrastructure, environment, facilities

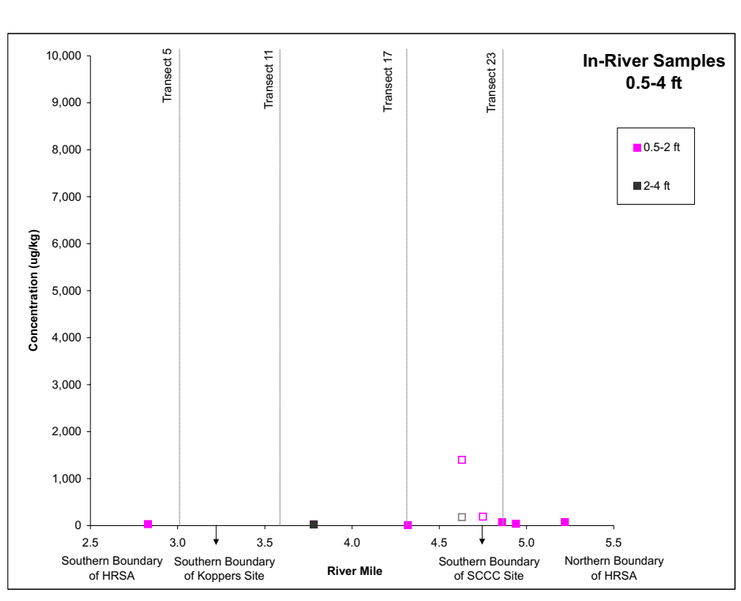
FIGURE
5-6

05/30/07 SYR-D85-DJH
09987015/09987G34.CDR









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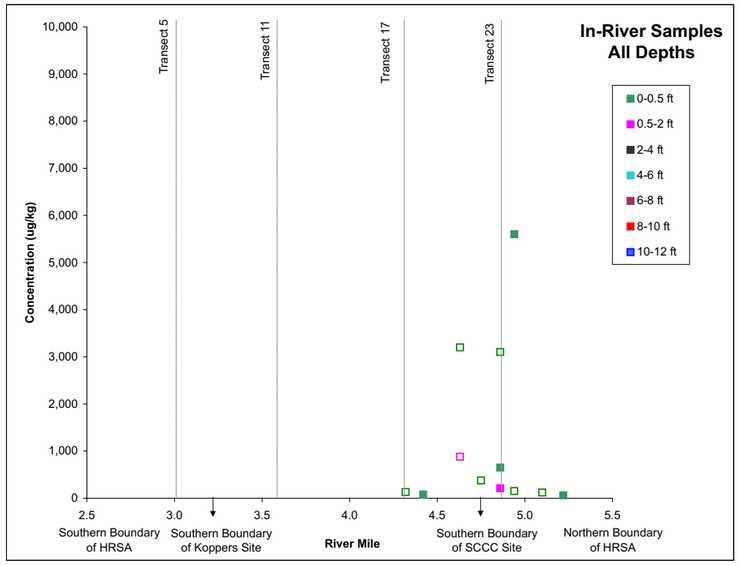
PENINSULA RESTORATION GROUP
HACKENSACK RIVER STUDY AREA
REMEDIAL INVESTIGATION REPORT

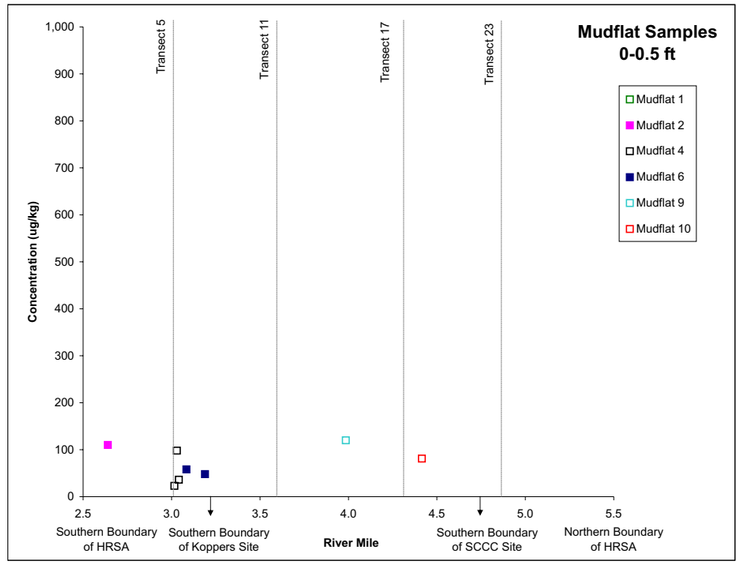
CONCENTRATION VS. RIVER MILE
1,4-DICHLOROBENZENE

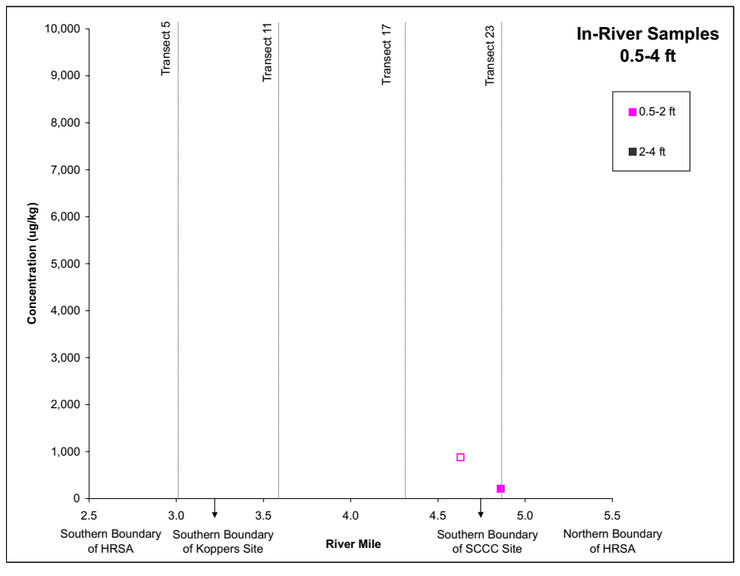
ARCADIS BBL
Infrastructure, environment, facilities

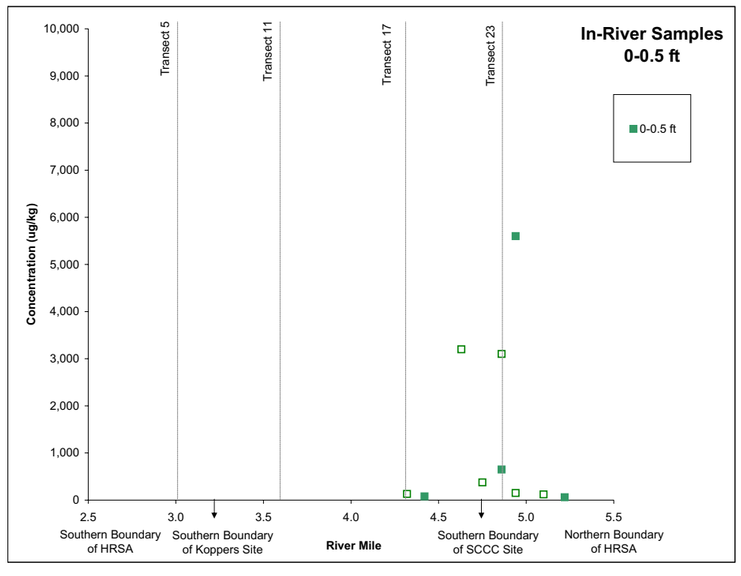
FIGURE
5-7

05/30/07 SYR-D85-DJH
09987015/09987G25.CDR









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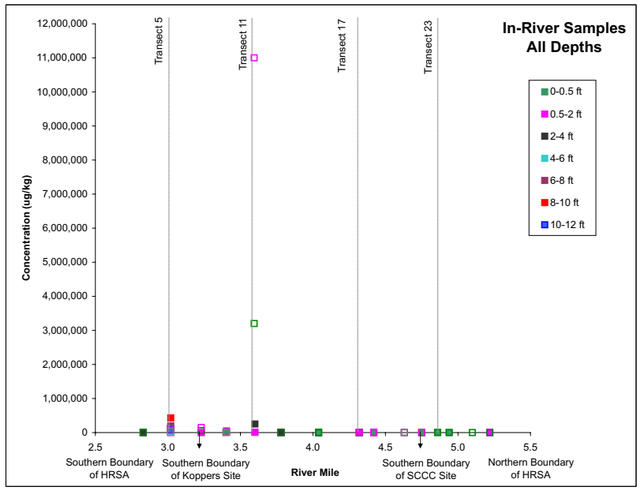
PENINSULA RESTORATION GROUP
HACKENSACK RIVER STUDY AREA
REMEDIAL INVESTIGATION REPORT

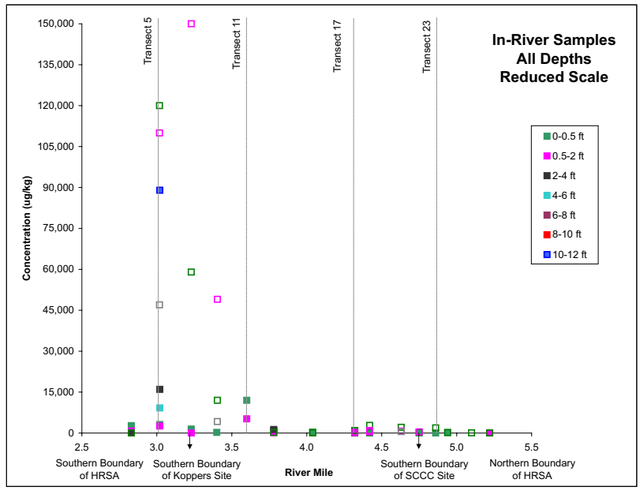
CONCENTRATION VS. RIVER MILE
1,2,4-TRICHLOROBENZENE

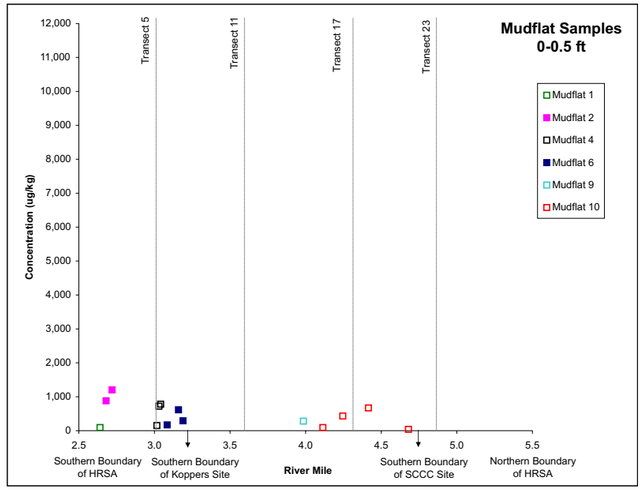
ARCADIS BBL
Infrastructure, environment, facilities

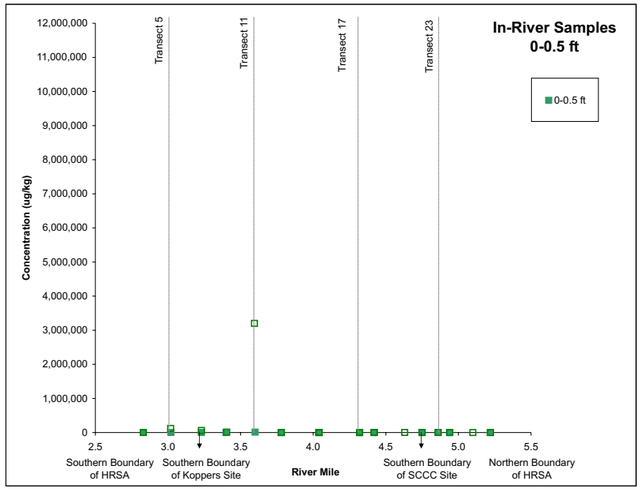
FIGURE
5-8

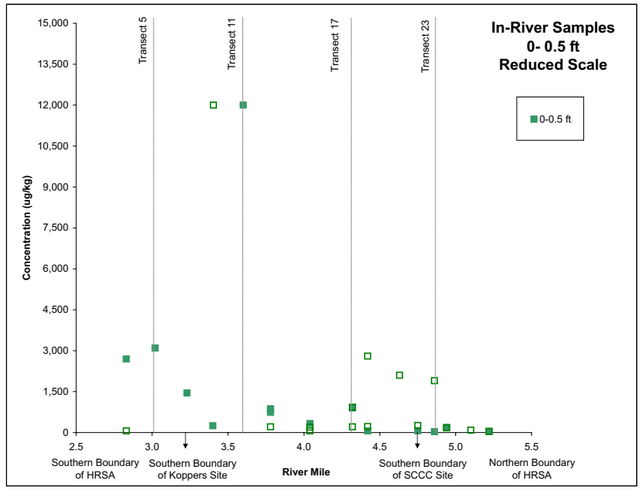
05/30/07 SYR-D85-DJH
09987015/09987G22.CDR

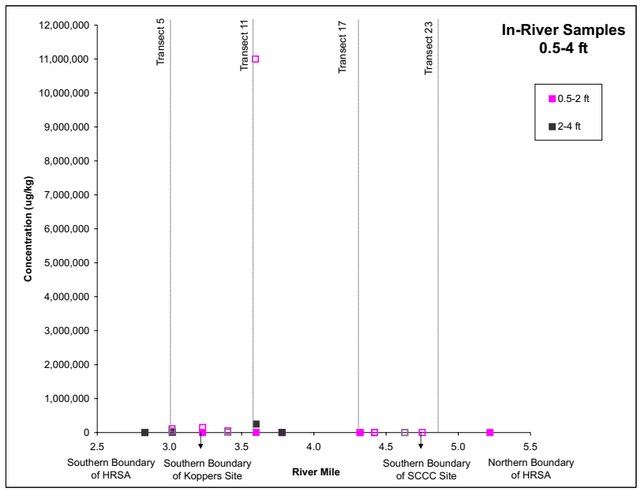


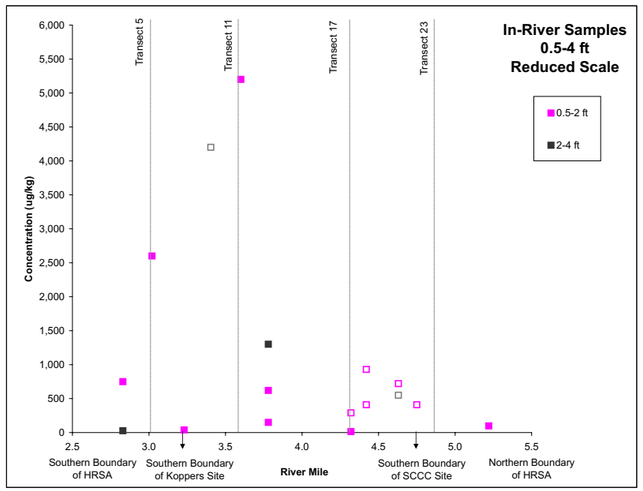












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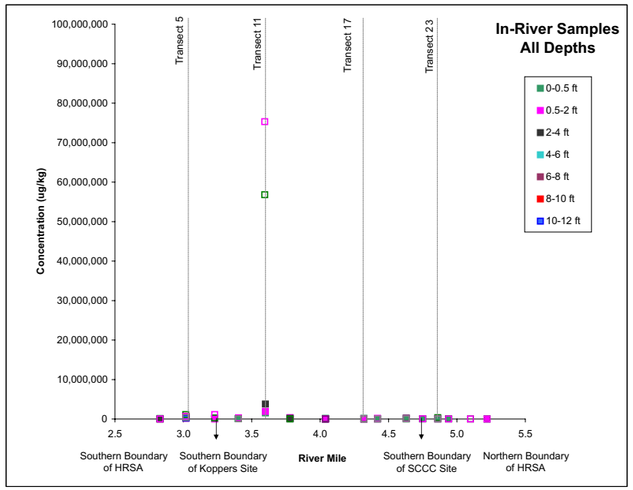
PENINSULA RESTORATION GROUP
HACKENSACK RIVER STUDY AREA
REMEDIAL INVESTIGATION REPORT

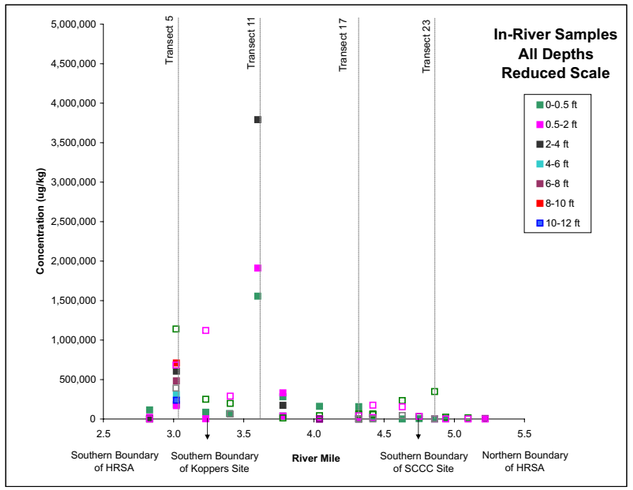
CONCENTRATION VS. RIVER MILE NAPHTHALENE

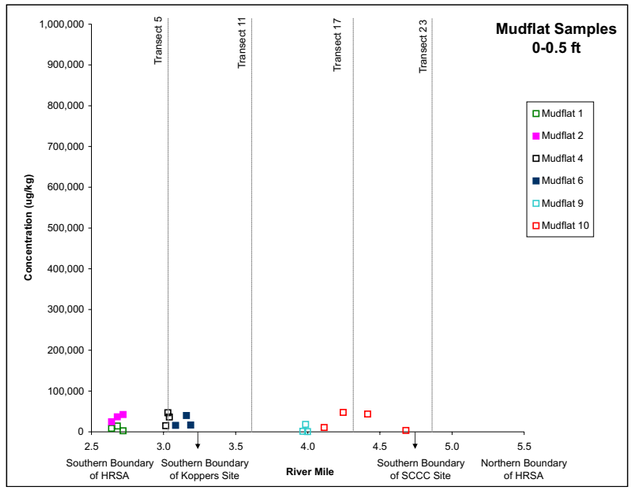
ARCADIS BBL
Infrastructure, environment, facilities

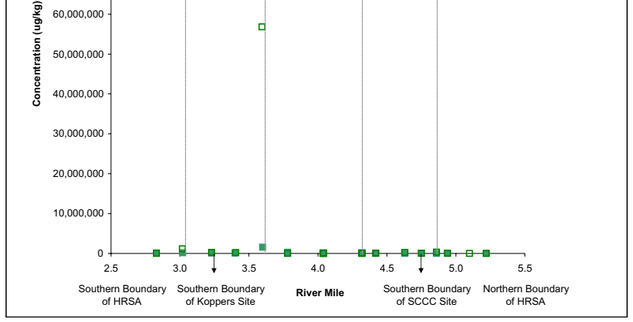
FIGURE 5-9

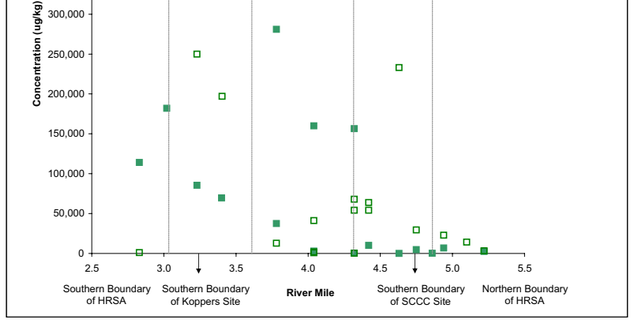
05/23/07 SYR-D85-DJH
09987015/09987G21.CDR

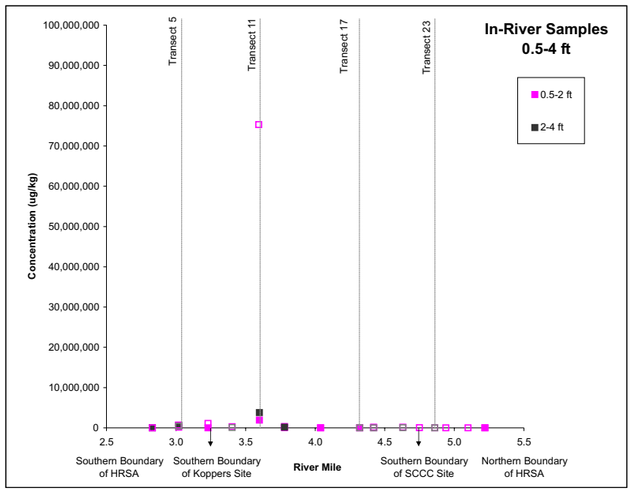


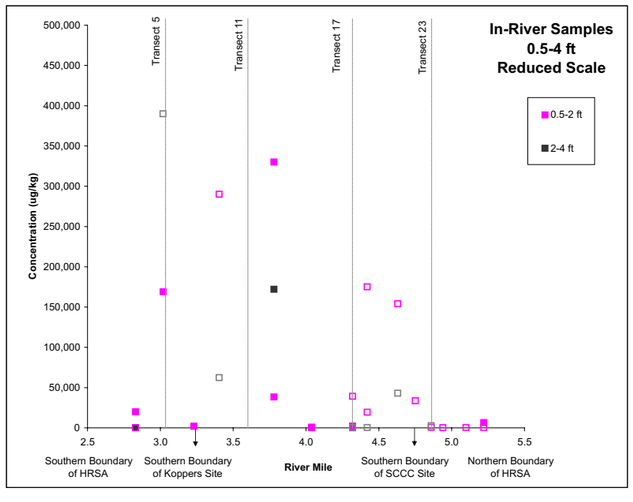












Notes:

1. Filled symbols represent results from the western side of the Hackensack River.
2. Open symbols represent results from the eastern side of the Hackensack River.
3. Reduced scale charts shown to provide more detail at lower concentrations. Certain analytical results showing relatively higher concentrations may be omitted for presentation purposes only.
4. Non-detect results were omitted from this figure due to elevated SQL values.
5. Field and duplicate sample results were averaged together to create one result.
6. ug/kg – micrograms per kilogram

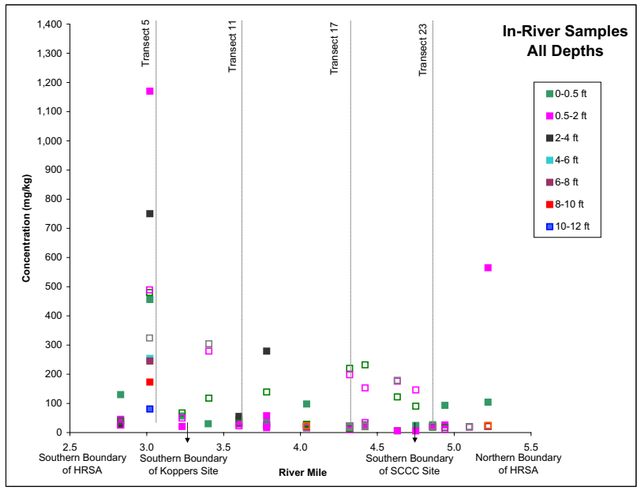
PENINSULA RESTORATION GROUP
HACKENSACK RIVER STUDY AREA
REMEDIAL INVESTIGATION REPORT

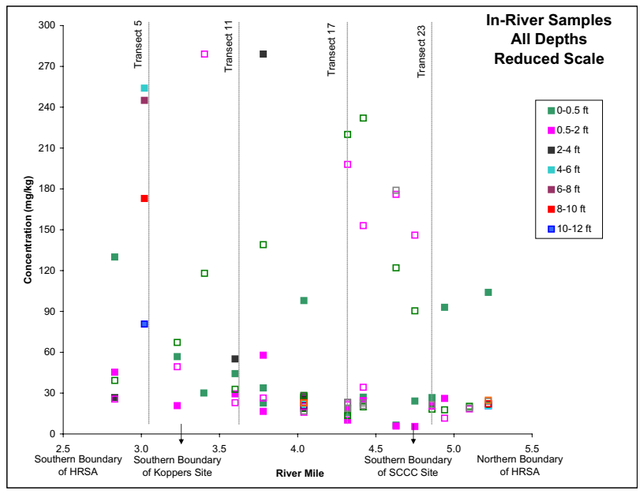
CONCENTRATION VS. RIVER MILE TOTAL PAHs

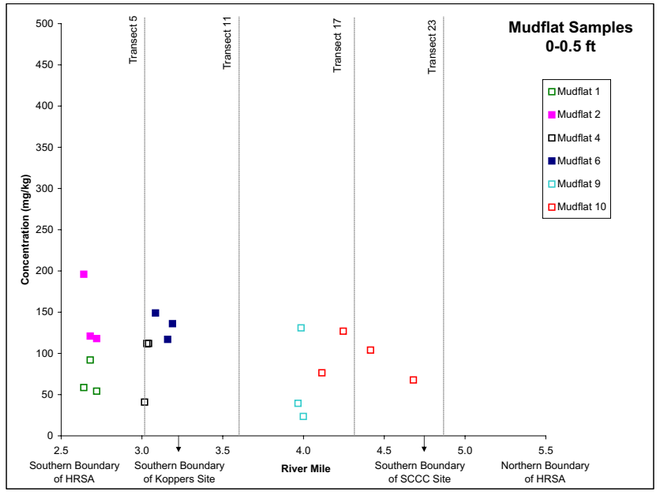
ARCADIS BBL
Infrastructure, environment, facilities

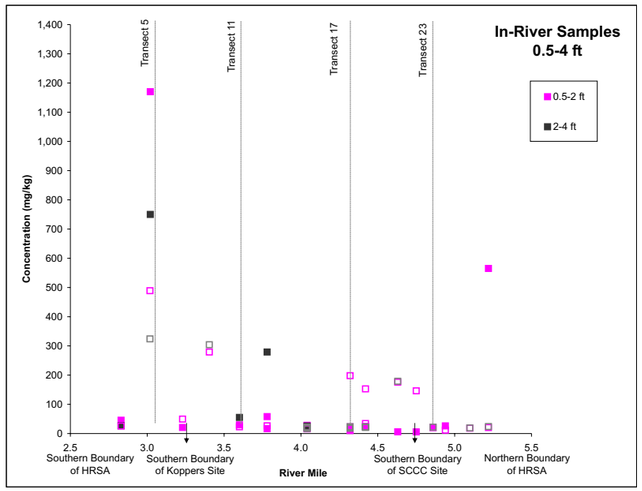
FIGURE 5-10

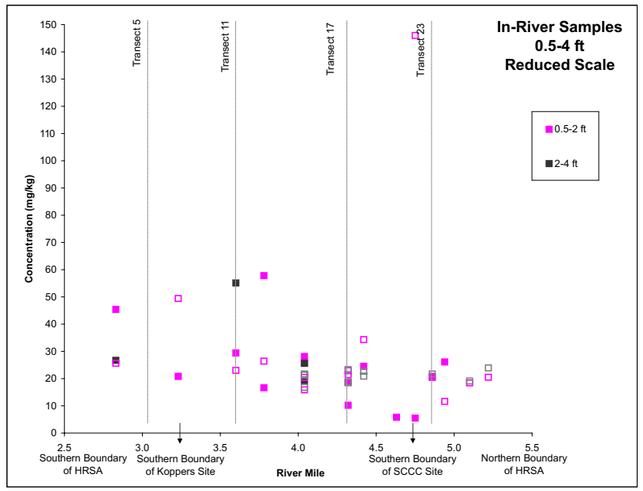
05/23/07 SYR-D85-DJH
09987015/09987G23.CDR

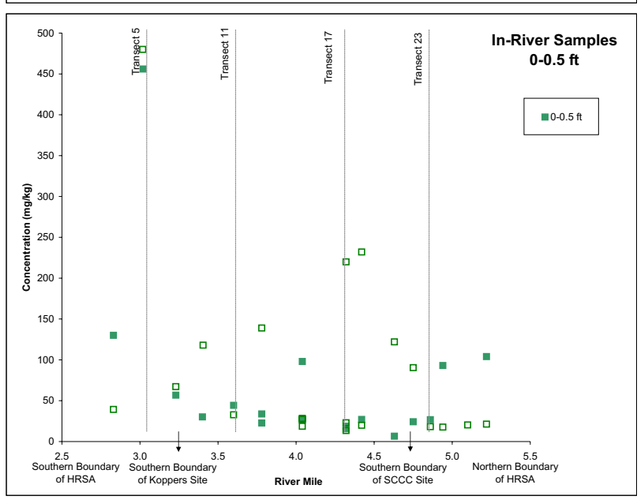


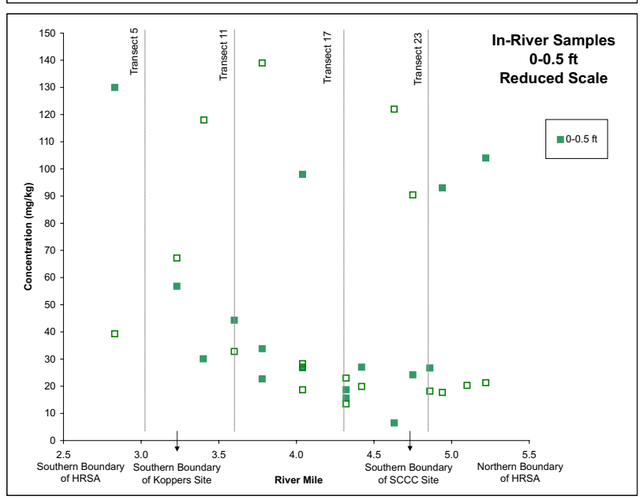












Notes:

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2. Open symbols represent results from the eastern side of the Hackensack River.
3. Reduced scale charts shown to provide more detail at lower concentrations. Certain analytical results showing relatively higher concentrations may be omitted for presentation purposes only.
4. Non-detect results are shown as one-half the detection limit.
5. Field and duplicate sample results were averaged together to create one result.
6. mg/kg – milligrams per kilogram

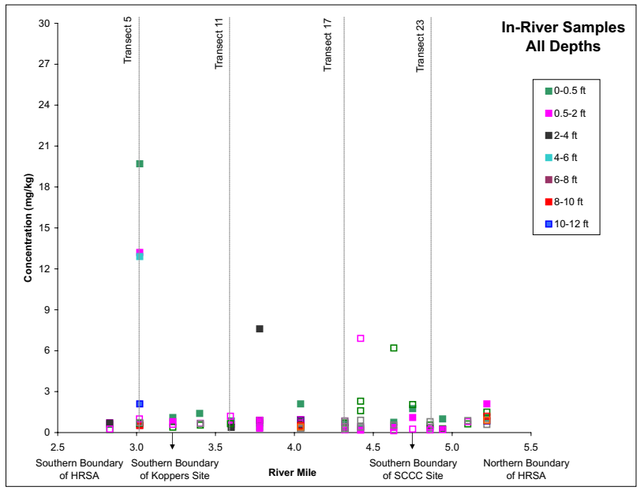
PENINSULA RESTORATION GROUP
HACKENSACK RIVER STUDY AREA
REMEDIAL INVESTIGATION REPORT

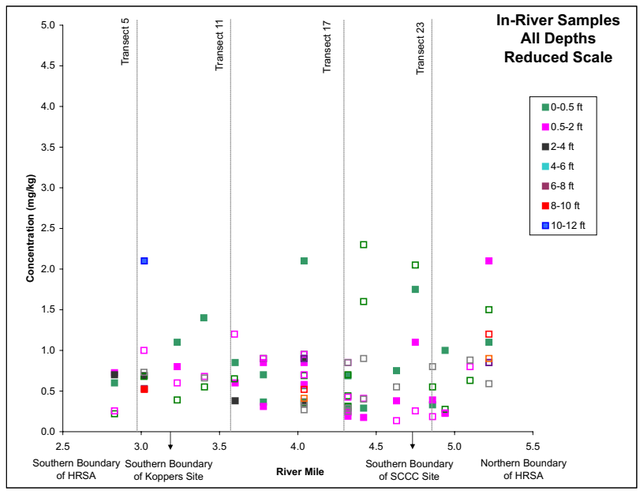
CONCENTRATION VS. RIVER MILE TOTAL CHROMIUM

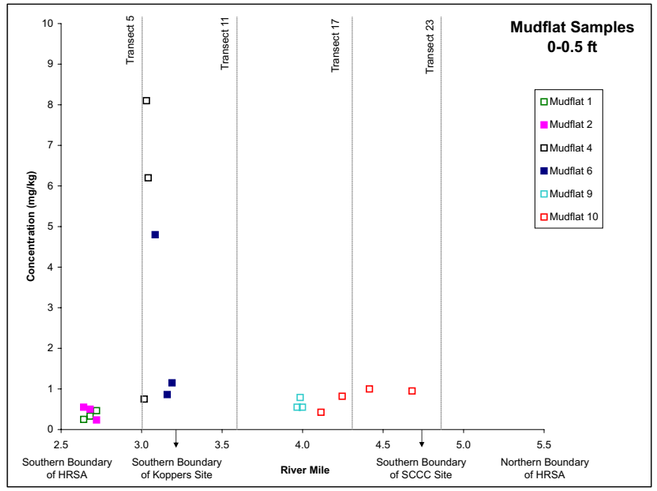
ARCADIS BBL
Infrastructure, environment, facilities

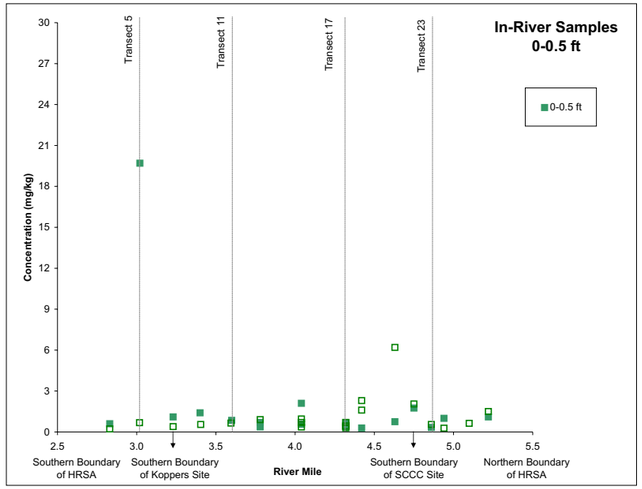
FIGURE 5-11

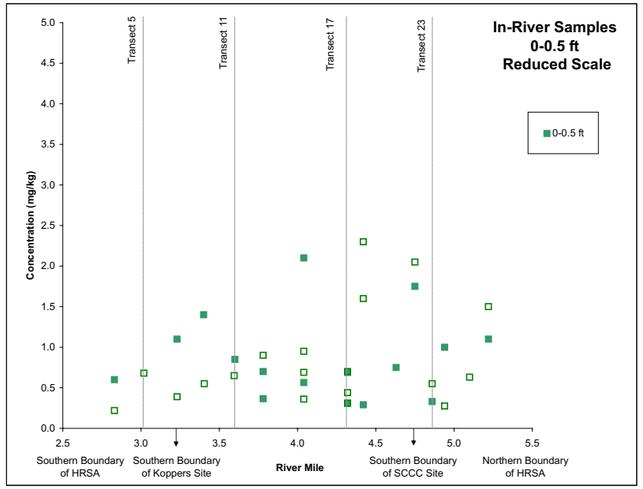
05/30/07 SYR-D85-DJH
09987015/09987G29.CDR

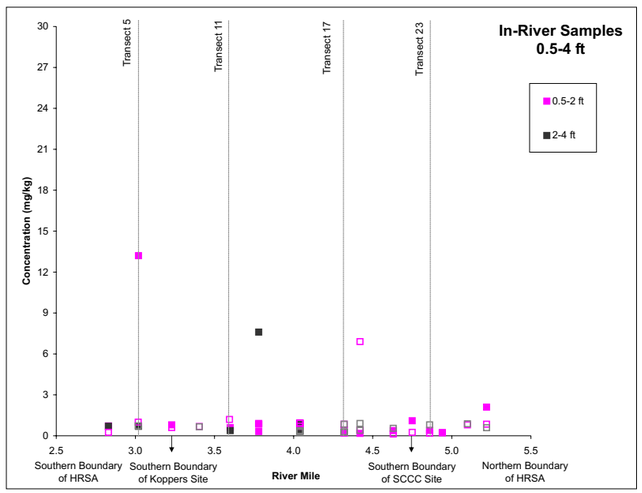


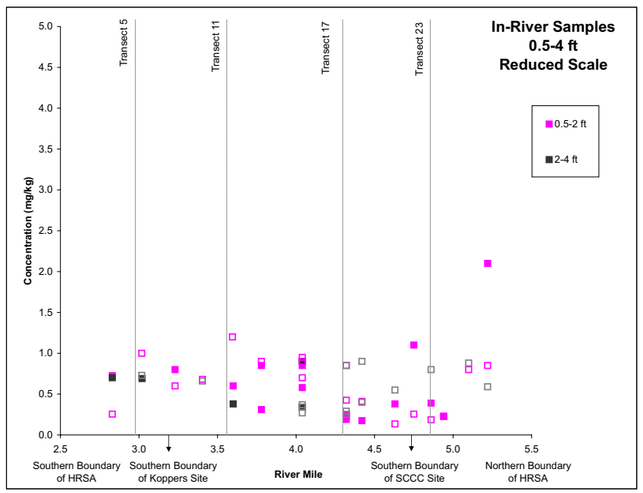












Notes:

1. Filled symbols represent results from the western side of the Hackensack River.
2. Open symbols represent results from the eastern side of the Hackensack River.
3. Reduced scale charts shown to provide more detail at lower concentrations. Certain analytical results showing relatively higher concentrations may be omitted for presentation purposes only.
4. Non-detect results are shown as one-half the detection limit.
5. Field and duplicate sample results were averaged together to create one result.
6. mg/kg – milligrams per kilogram

PENINSULA RESTORATION GROUP
HACKENSACK RIVER STUDY AREA

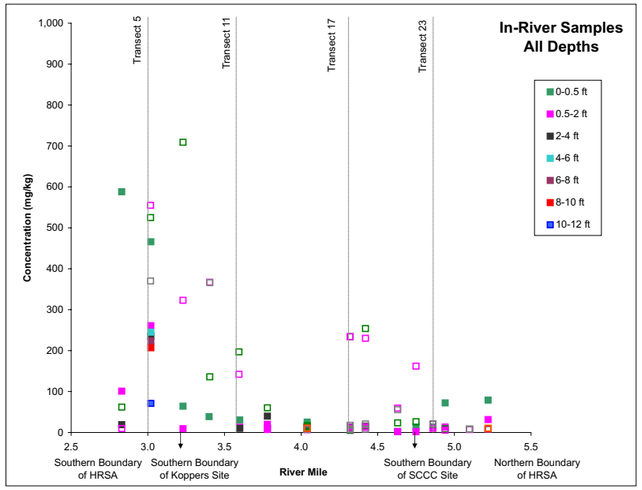
REMEDIAL INVESTIGATION REPORT

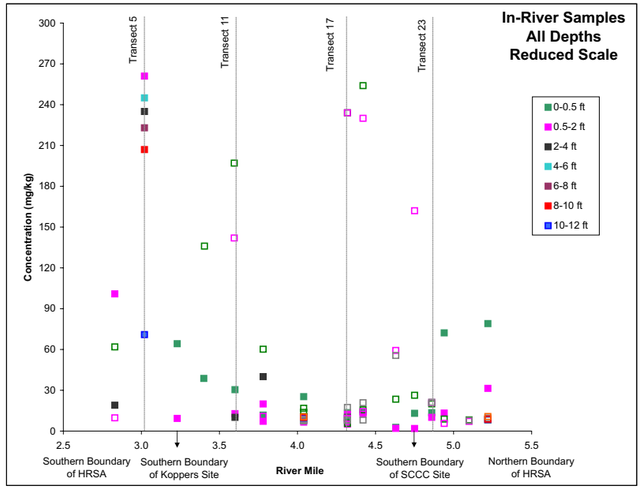
CONCENTRATION VS. RIVER MILE HEXAVALENT CHROMIUM

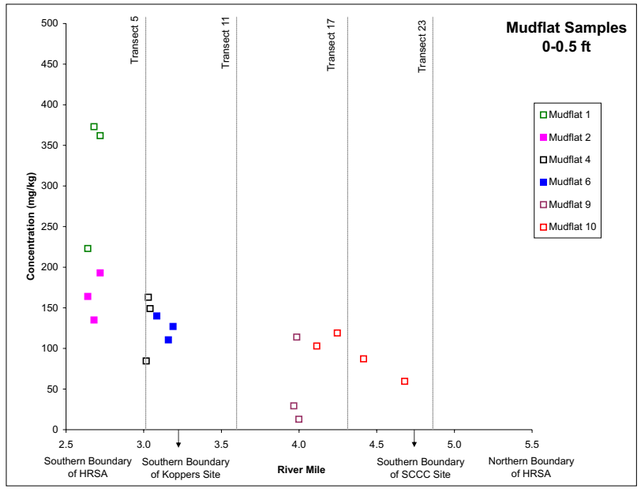
ARCADIS BBL
Infrastructure, environment, facilities

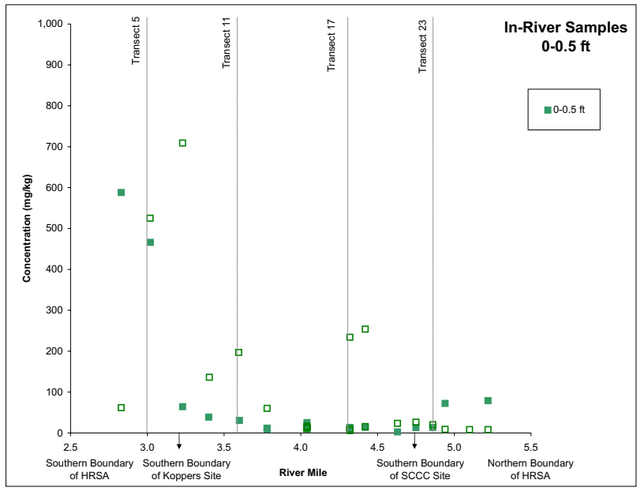
FIGURE 5-12

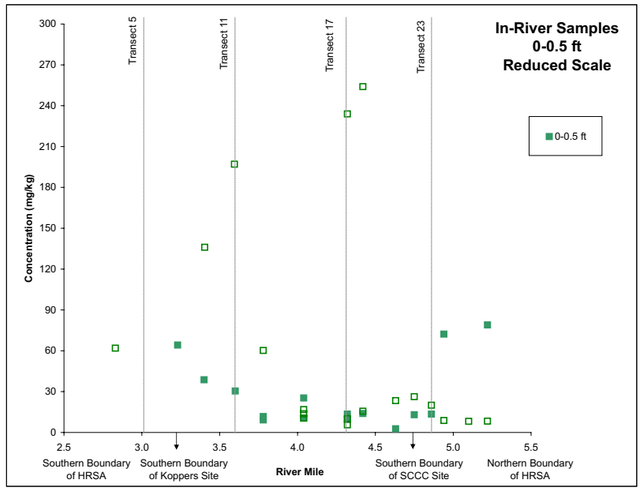
05/24/07 SYR-D85-DJH
099870150099870G30.CDR

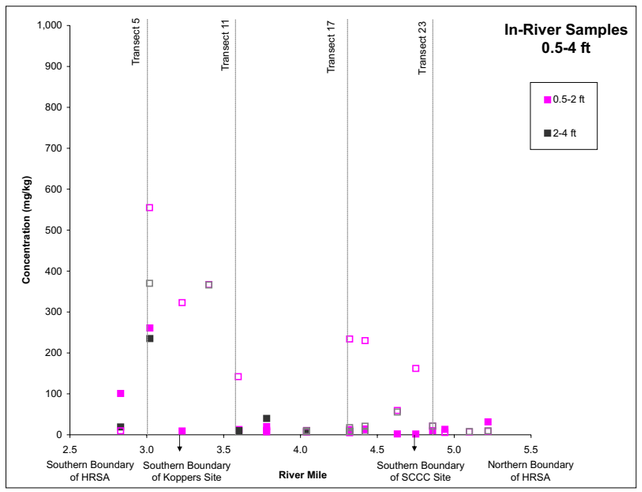


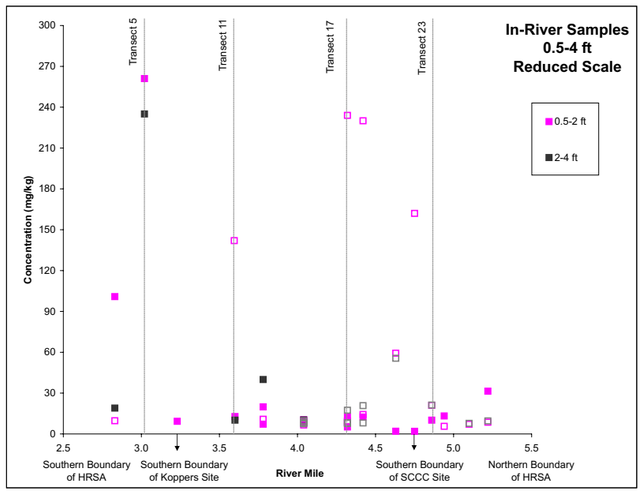












Notes:

1. Filled symbols represent results from the western side of the Hackensack River.
2. Open symbols represent results from the eastern side of the Hackensack River.
3. Reduced scale charts shown to provide more detail at lower concentrations. Certain analytical results showing relatively higher concentrations may be omitted for presentation purposes only.
4. Non-detect results are shown as one-half the detection limit.
5. Field and duplicate sample results were averaged together to create one result.
6. mg/kg – milligrams per kilogram

PENINSULA RESTORATION GROUP
HACKENSACK RIVER STUDY AREA

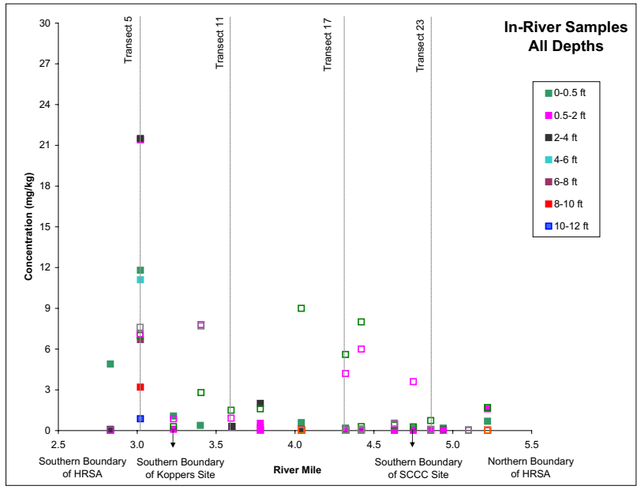
REMEDIAL INVESTIGATION REPORT

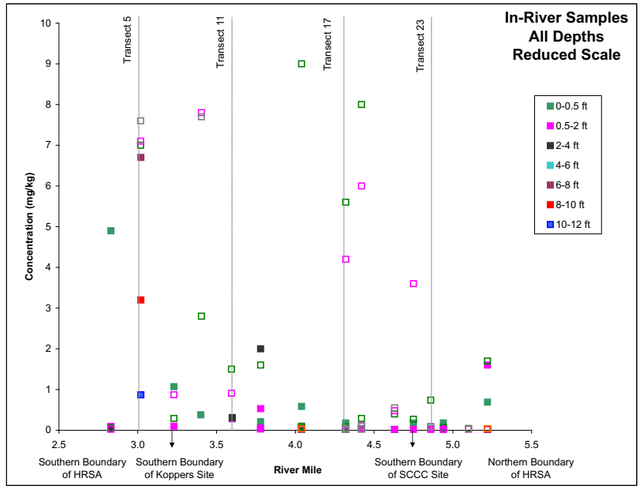
CONCENTRATION VS. RIVER MILE LEAD

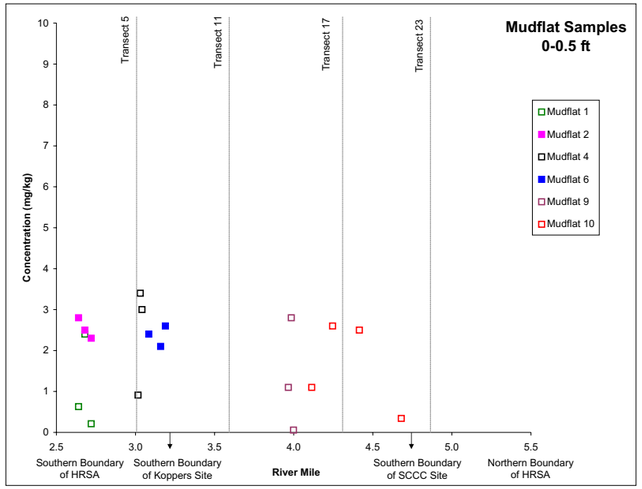
ARCADIS BBL
Infrastructure, environment, facilities

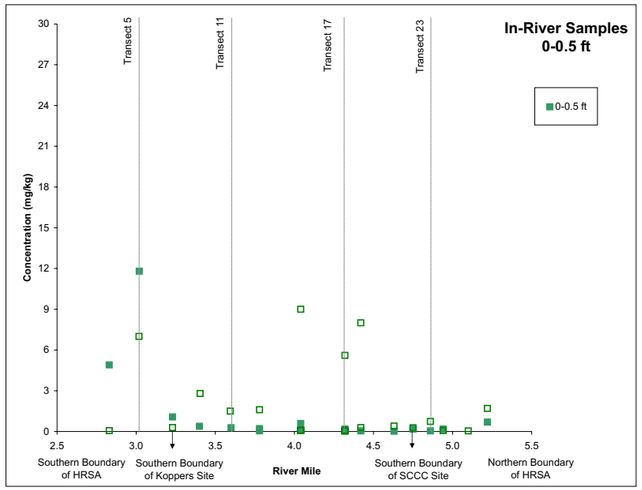
FIGURE 5-13

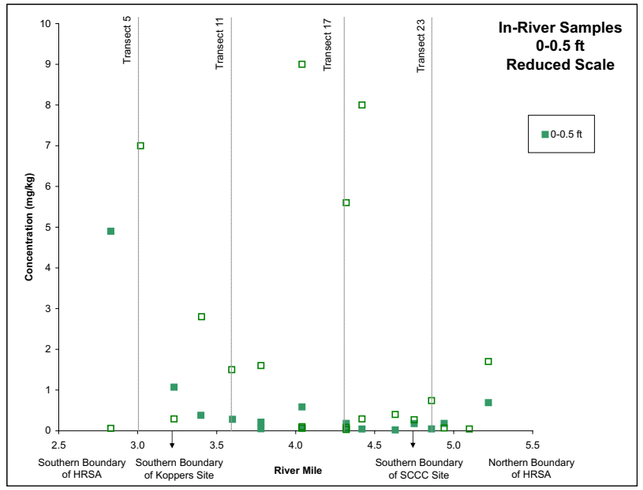
05/30/07 SYR-D85-DJH
09987015/09987G06.CDR

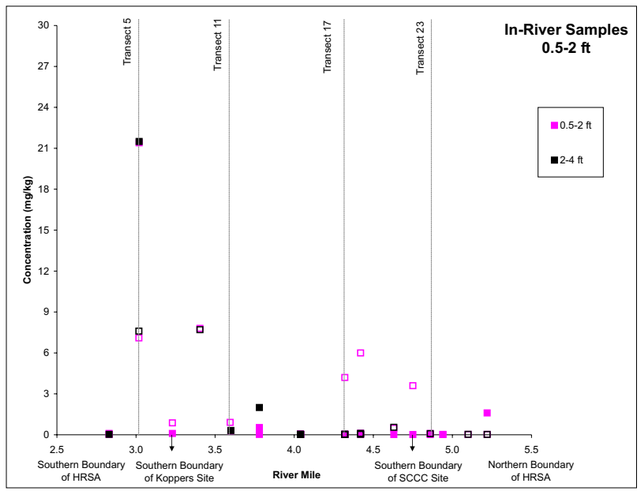


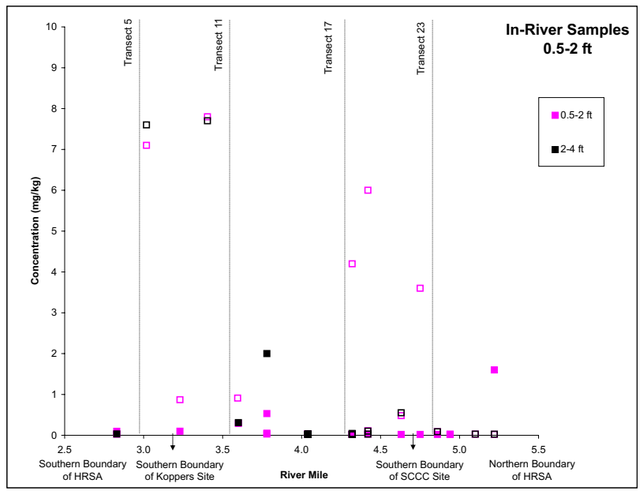












Notes:

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3. Reduced scale charts shown to provide more detail at lower concentrations. Certain analytical results showing relatively higher concentrations may be omitted for presentation purposes only.
4. Non-detect results are shown as one-half the detection limit.
5. Field and duplicate sample results were averaged together to create one result.
6. mg/kg – milligrams per kilogram

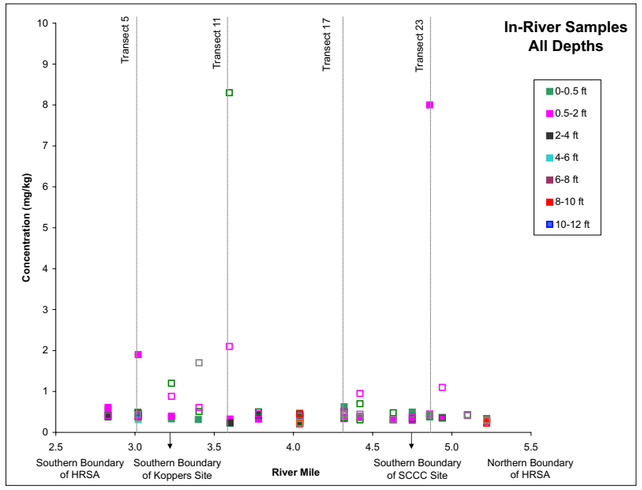
PENINSULA RESTORATION GROUP
HACKENSACK RIVER STUDY AREA
REMEDIAL INVESTIGATION REPORT

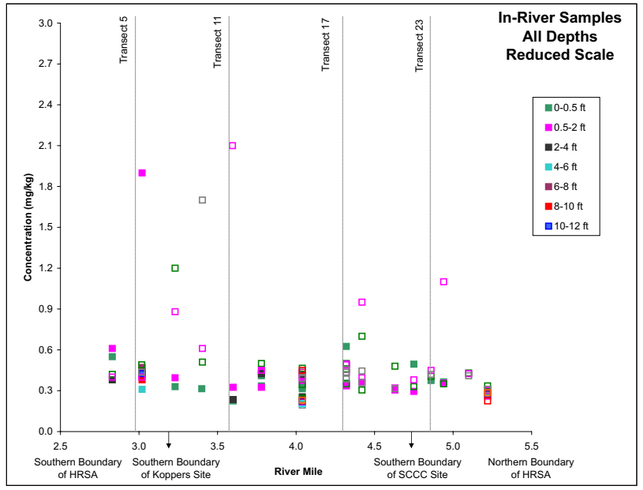
CONCENTRATION VS. RIVER MILE MERCURY

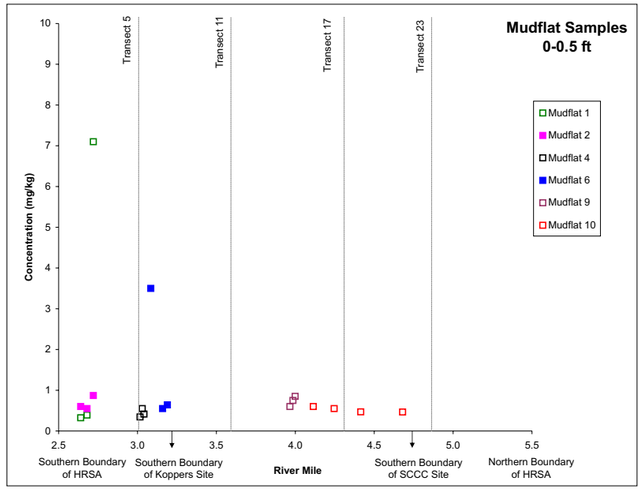
ARCADIS BBL
Infrastructure, environment, facilities

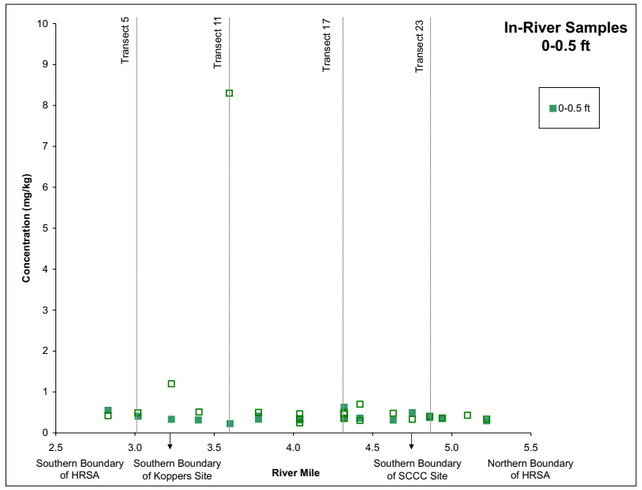
FIGURE 5-14

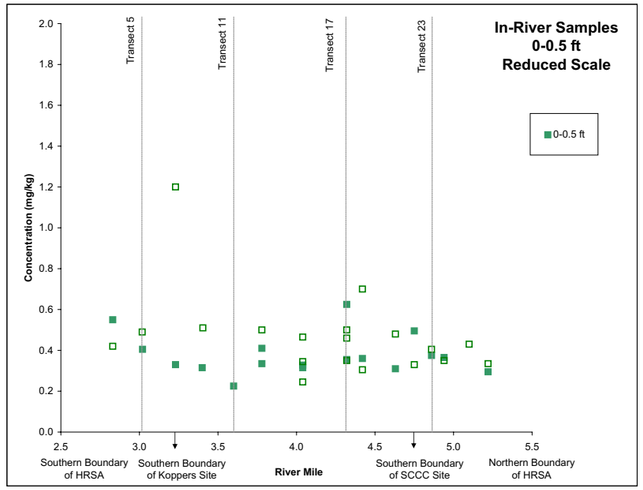
04/27/07 SYR-D85-DJH
09987015/09987G07.CDR

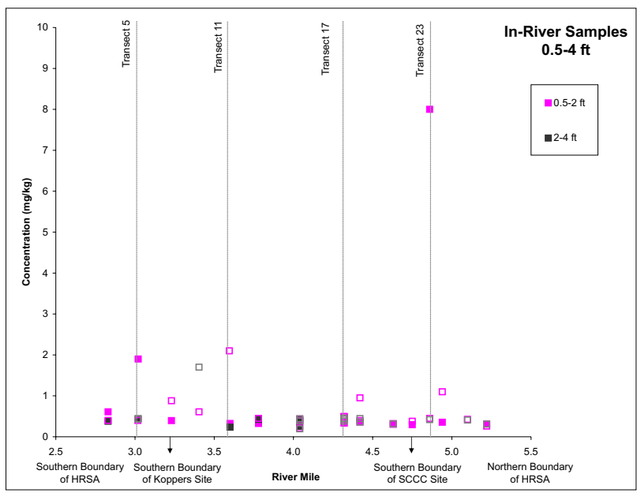


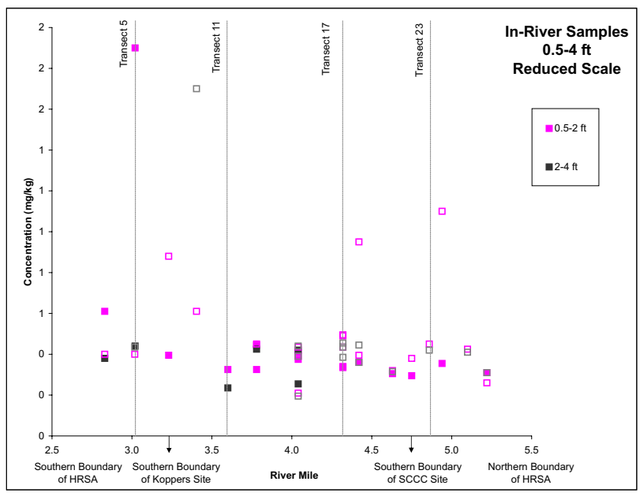












Notes:

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2. Open symbols represent results from the eastern side of the Hackensack River.
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4. Non-detect results are shown as one-half the detection limit.
5. Field and duplicate sample results were averaged together to create one result.
6. mg/kg – milligrams per kilogram

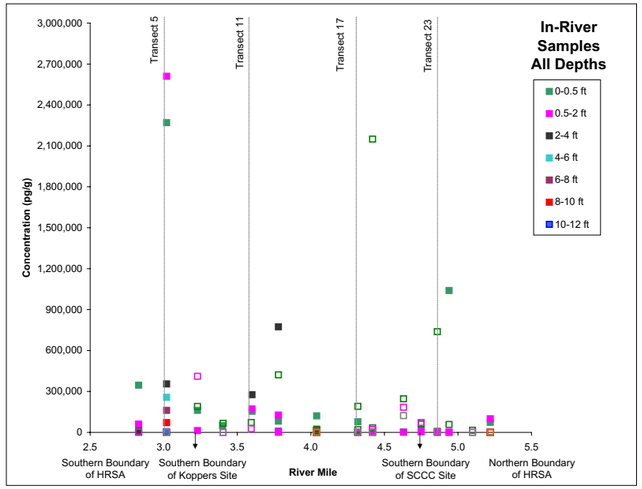
PENINSULA RESTORATION GROUP
HACKENSACK RIVER STUDY AREA
REMEDIAL INVESTIGATION REPORT

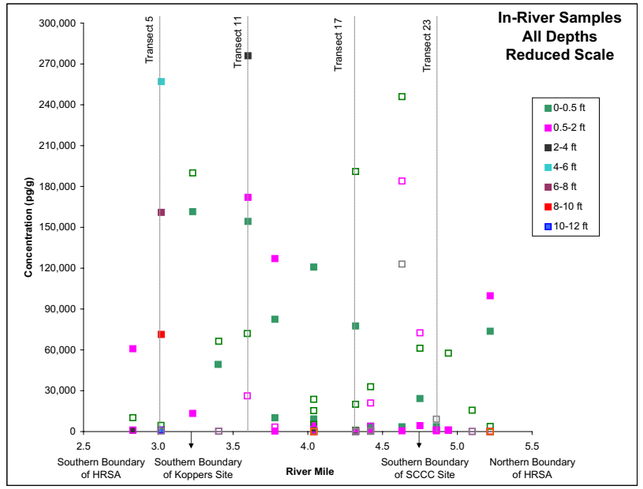
CONCENTRATION VS. RIVER MILE CYANIDE

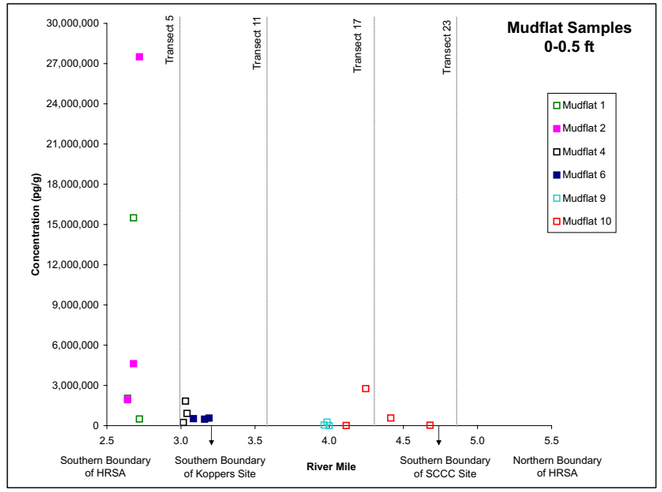
ARCADIS BBL
Infrastructure, environment, facilities

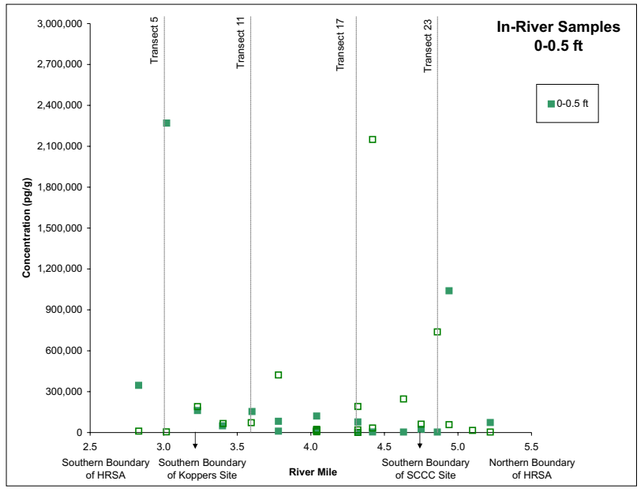
FIGURE 5-15

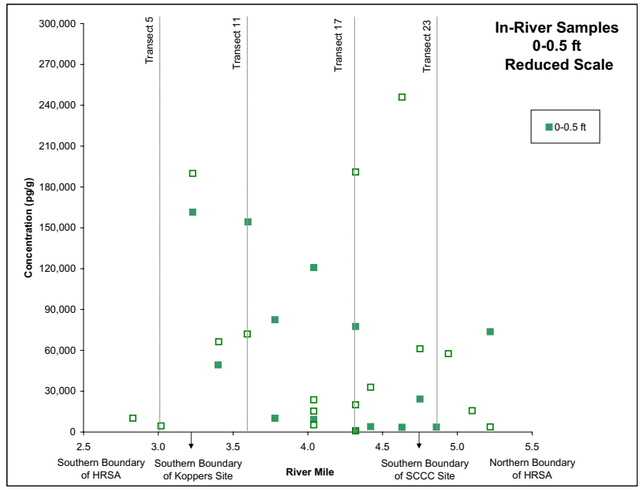
05/30/07 SYR-D65-DJH
0998701S/0998TG08.CDR

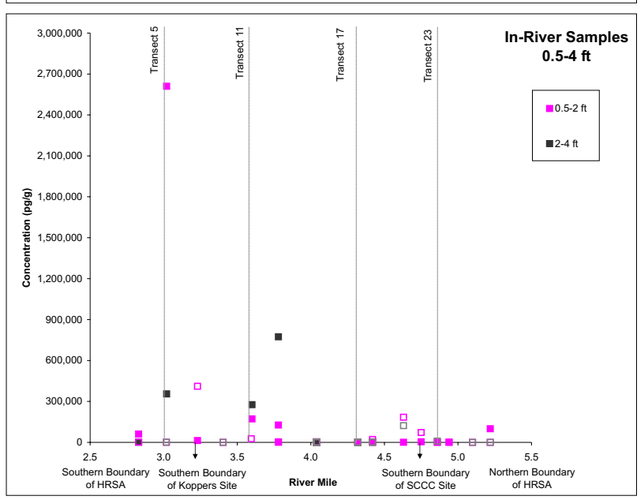


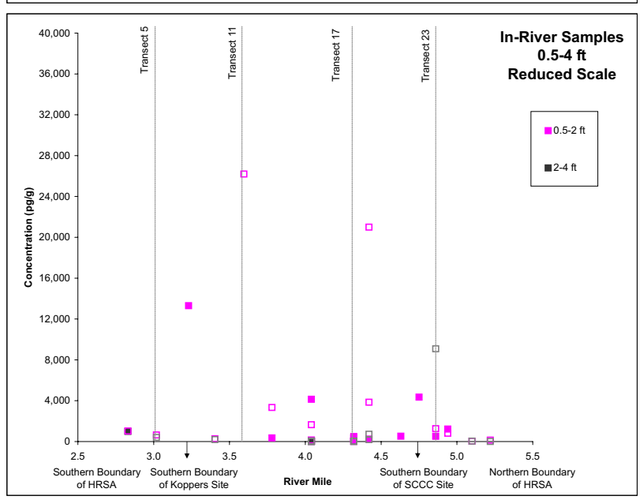












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4. Non-detect results are shown as one-half the detection limit.
5. Field and duplicate sample results were averaged together to create one result.
6. pg/g – picograms per gram

PENINSULA RESTORATION GROUP
HACKENSACK RIVER STUDY AREA

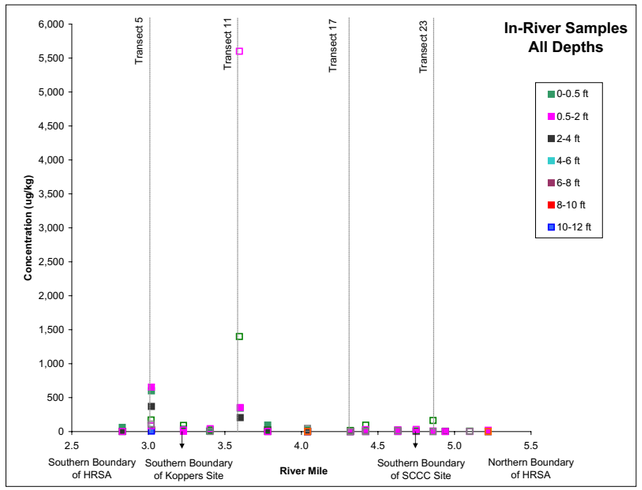
REMEDIAL INVESTIGATION REPORT

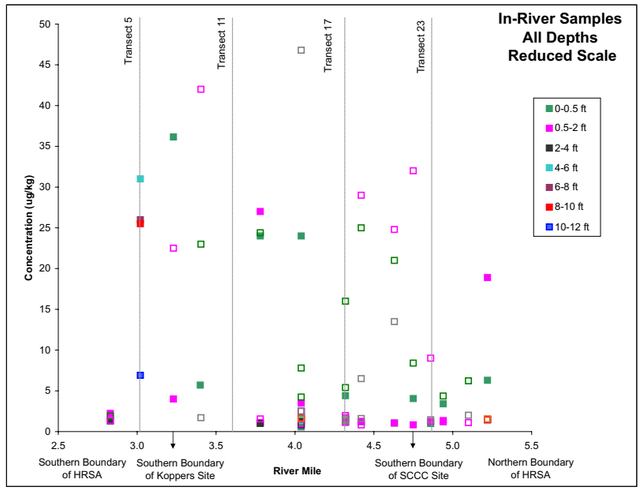
CONCENTRATION VS. RIVER MILE TOTAL CONGENER PCBs

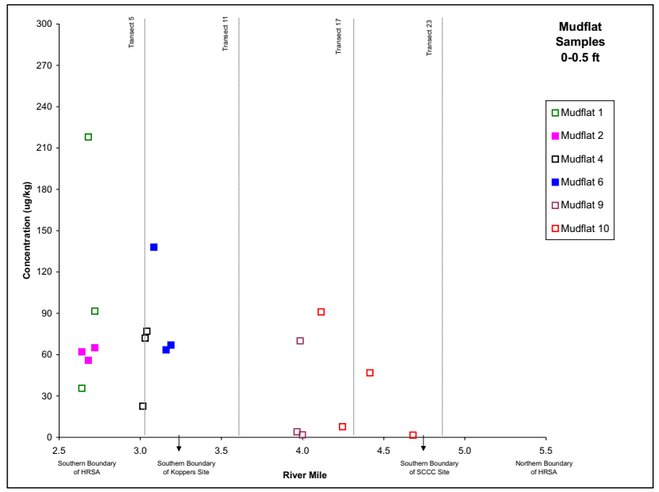
ARCADIS BBL
Infrastructure, environment, facilities

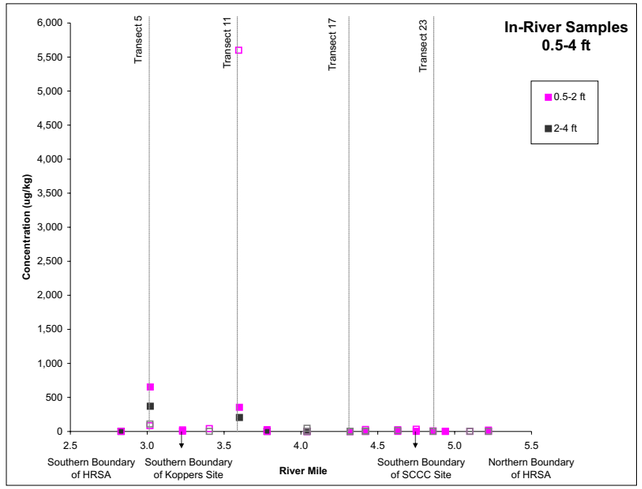
FIGURE 5-16

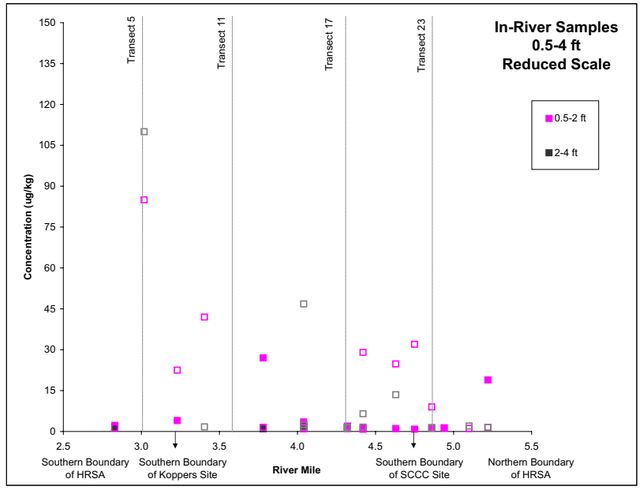
05/30/07 SYR-D85-DJH
09987015/09987G27.CDR

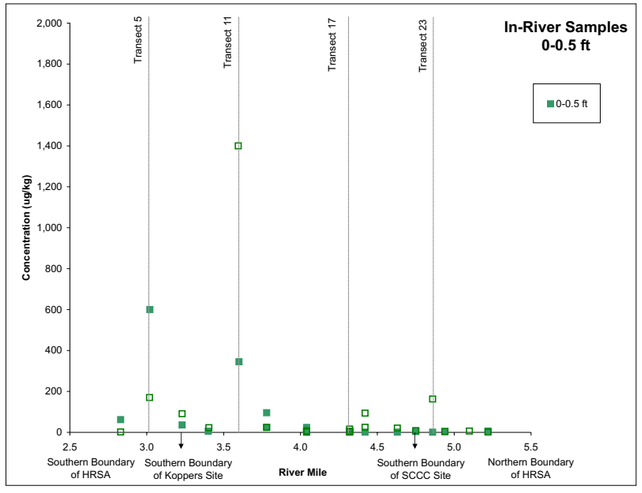


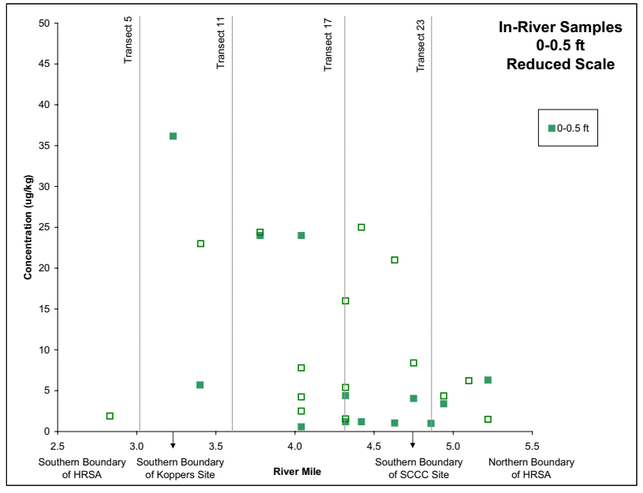












Notes:

1. Filled symbols represent results from the western side of the Hackensack River.
2. Open symbols represent results from the eastern side of the Hackensack River.
3. Reduced scale charts shown to provide more detail at lower concentrations. Certain analytical results showing relatively higher concentrations may be omitted for presentation purposes only.
4. Non-detect results are shown as one-half the detection limit.
5. Field and duplicate sample results were averaged together to create one result.
6. ug/kg – micrograms per kilogram

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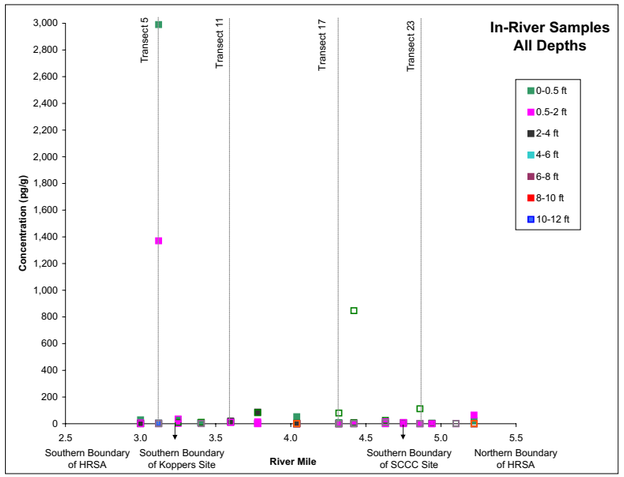
HACKENSACK RIVER STUDY AREA
REMEDIAL INVESTIGATION REPORT

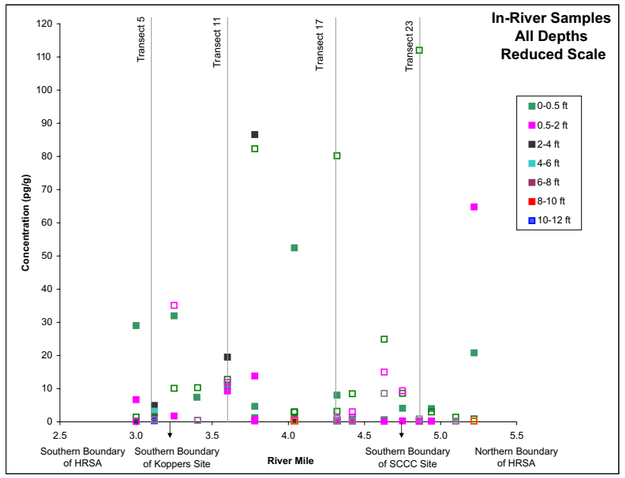
CONCENTRATION VS. RIVER MILE TOTAL DDT

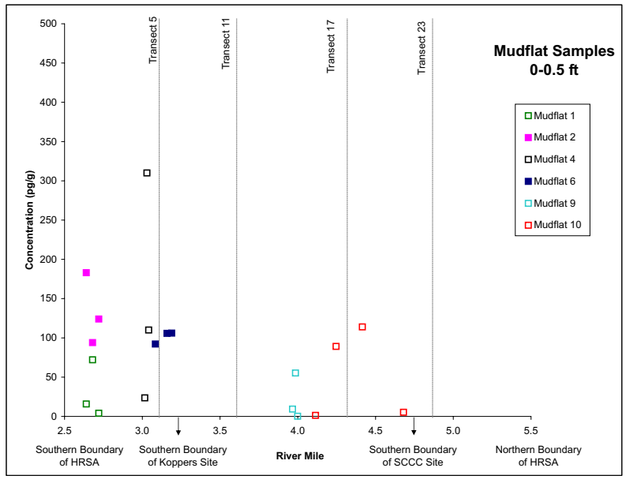
ARCADIS BBL
Infrastructure, environment, facilities

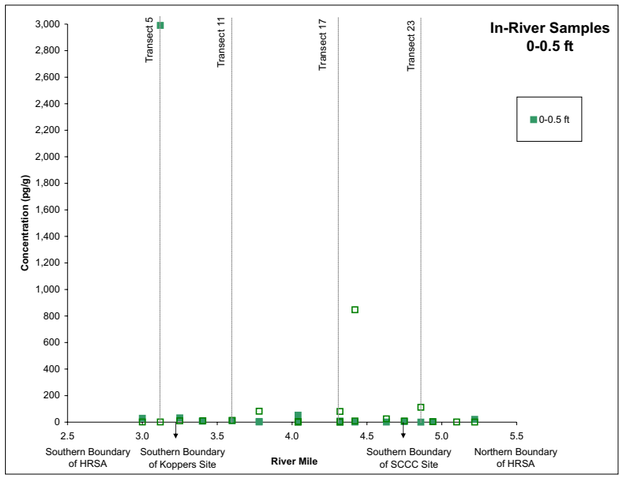
FIGURE 5-17

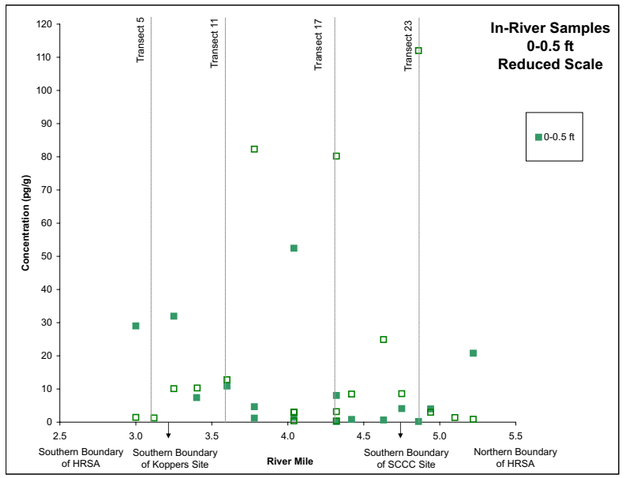
05/30/07 SYR-D85-DJH
09987015/09987G03.CDR

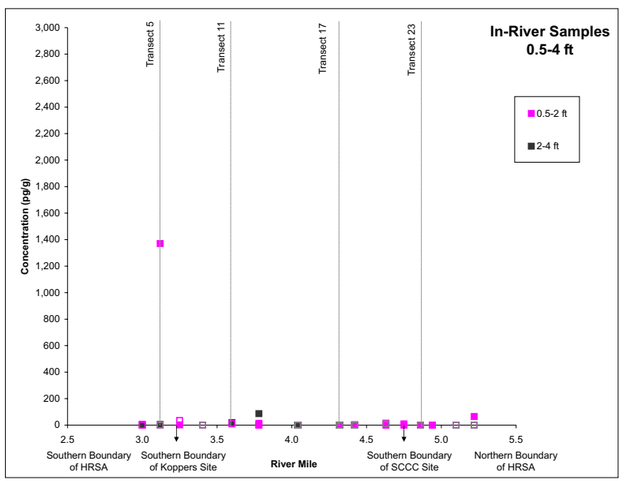


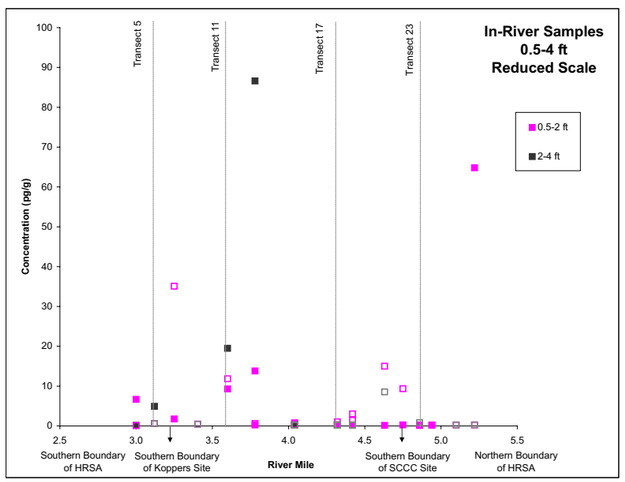












Notes:

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4. Non-detect results are shown as one-half the detection limit.
5. Field and duplicate sample results were averaged together to create one result.
6. pg/g – picograms per gram

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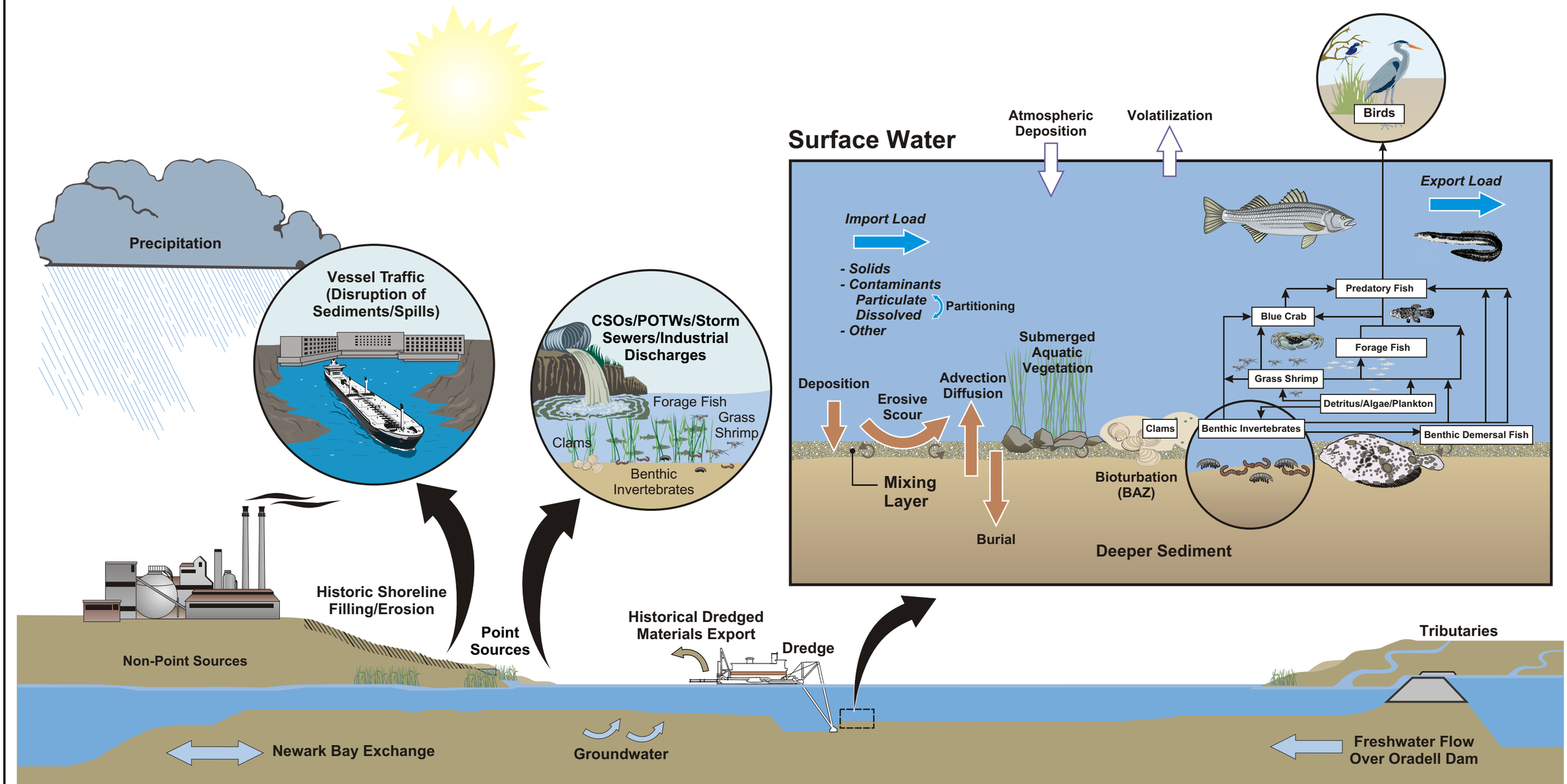
REMEDIAL INVESTIGATION REPORT

CONCENTRATION VS. RIVER MILE 2,3,7,8-TCDD

ARCADIS BBL
Infrastructure, environment, facilities

FIGURE 5-18

05/24/07 SYR-D85-DJH
09987015/09987G26.CDR



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HACKENSACK RIVER STUDY AREA

REMEDIAL INVESTIGATION REPORT

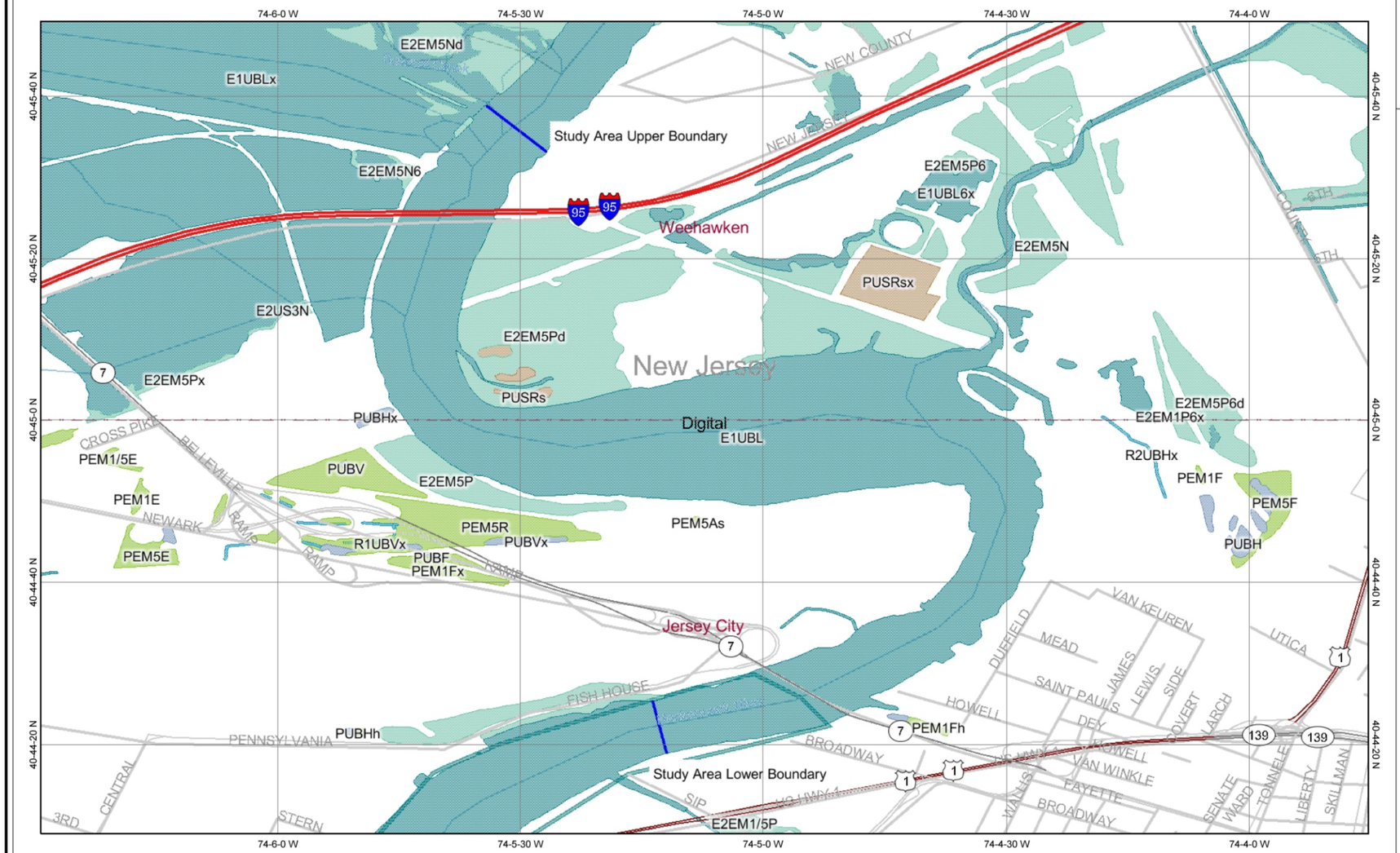
PRELIMINARY CONCEPTUAL SITE MODEL OF HACKENSACK RIVER FATE AND TRANSPORT PROCESSES

ARCADIS BBL
Infrastructure, environment, facilities

FIGURE 6-1

05/15/07 SYR-D85-DJH
099670150998/g20.CDR

USFWS NWI MAP OF THE HRSA



Legend

- CONUS_wet_scan
  - 0
  - 1
  - Out of range
- Interstate
- Major Roads
- Other Road
- Interstate
- State highway
- US highway
- Roads
- Cities
- USGS Quad Index 24K
- Lower 48 Wetland Polygons
  - Estuarine and Marine Deepwater
  - Estuarine and Marine Wetland
  - Freshwater Emergent Wetland
  - Freshwater Forested/Shrub Wetland
  - Freshwater Pond
  - Lake
  - Other
  - Riverine
- Lower 48 Available Wetland Data
  - Non-Digital
  - Digital
  - No Data
  - Scan
- NHD Streams
- Counties 100K
- Urban Areas 300K
- States 100K
- South America
- North America

Scale: 1:20,000

Map center: 40° 44' 59" N, 74° 5' 7" W

This map is a user generated static output from an Internet mapping site and is for general reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. THIS MAP IS NOT TO BE USED FOR NAVIGATION.

PENINSULA RESTORATION GROUP
HACKENSACK RIVER STUDY AREA

REMEDIAL INVESTIGATION REPORT

U.S. FISH & WILDLIFE SERVICE NATIONAL WETLANDS INVENTORY (NWI) MAP FOR THE HRSA ENVIRONS

ARCADIS BBL
Infrastructure, environment, facilities

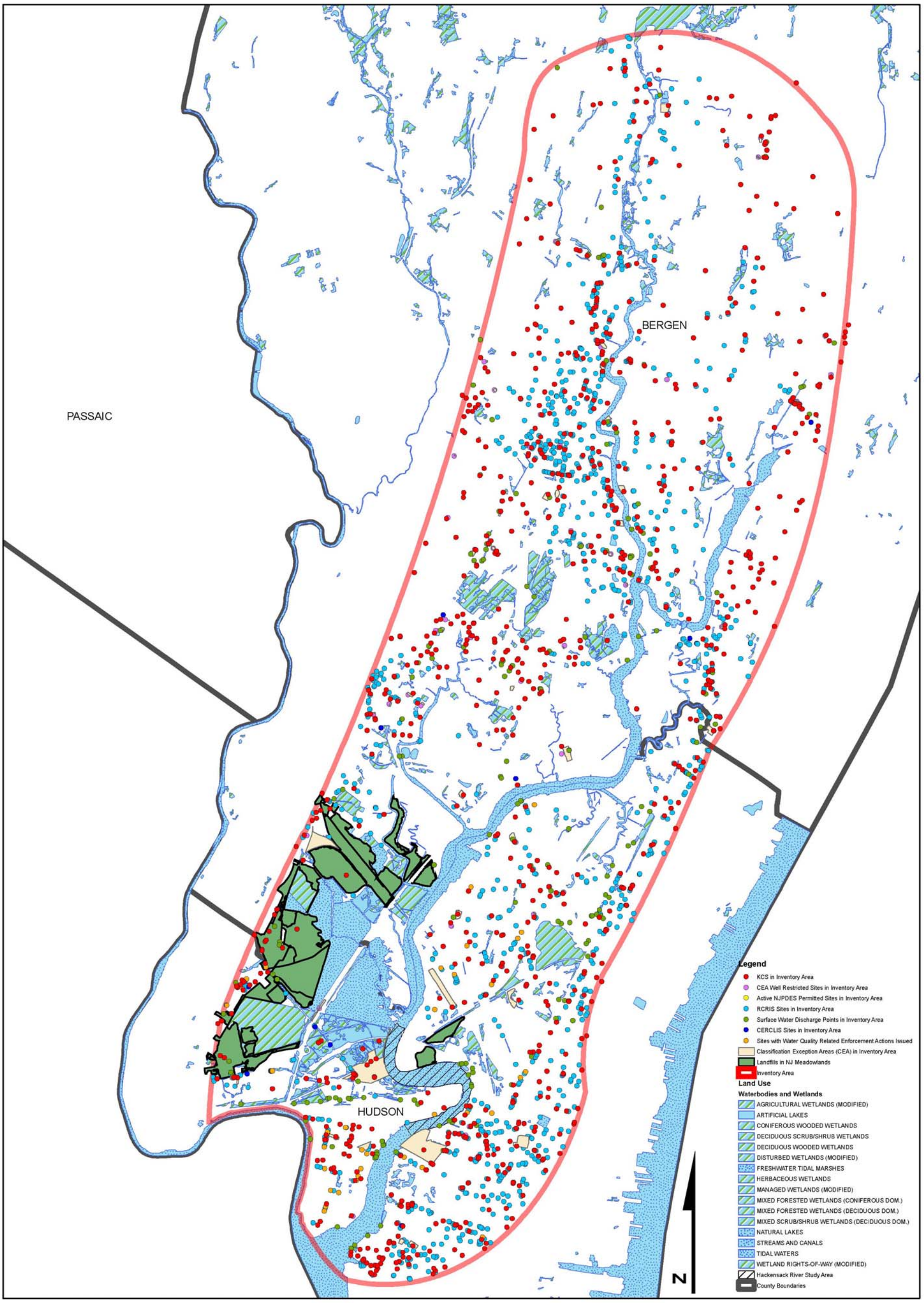
FIGURE
6-2

05/15/07 SYR-D85-DJH
09987015\09987N01.CDR

Attachment 1

Potential Sources of Impact to the Hackensack River

POTENTIAL SOURCES OF IMPACT TO THE HACKENSACK RIVER



SOURCE INFORMAITON FOR ATTACHMENT 1 – POTENTIAL SOURCES OF IMPACT TO THE HACKENSACK RIVER

CERCLIS Sites - U.S. EPA Comprehensive Environmental Response, Compensation, and Liability Act Information System (www.epa.gov/enviro/html/cerclis/cerclis_query.html). Last Updated: May 6, 2005

Classification Exception Areas - New Jersey Department of Environmental Protection iMapNJ GIS website (www.state.nj.us/dep/gis/imapnj/imapnj.htm#). Last Updated: February 2004

Classification Exception Areas (Well Restricted) - New Jersey Department of Environmental Protection iMapNJ GIS website (www.state.nj.us/dep/gis/imapnj/imapnj.htm#). Last Updated: February 2004

Known Contaminated Sites - New Jersey Department of Environmental Protection iMapNJ GIS website (www.state.nj.us/dep/gis/imapnj/imapnj.htm#). Last Updated: 2001

Landfills in NJ Meadowlands – U.S. Army Corps of Engineers - Meadowlands Environmental Site Investigation Compilation (MESIC), May 2004. Last Updated: May 2004

NJPDES Sites – New Jersey Department of Environmental Protection's Division of Water Quality permit database (www.state.nj.us/dep/dwq/database.htm). Last Updated: May 11, 2005

RCRA Facilities - U.S. EPA Resource Conservation and Recovery Act Information System (www.epa.gov/enviro/html/rcris/rcris_query_java.html). Last Updated: December 18, 2003

RCRA Facilities (Large Quantity Generators) - U.S. EPA Resource Conservation and Recovery Act Information System (www.epa.gov/enviro/html/rcris/rcris_query_java.html). Last Updated: December 18, 2003

Surface Water Discharge Points - New Jersey Department of Environmental Protection iMapNJ GIS website (www.state.nj.us/dep/gis/imapnj/imapnj.htm#). Last Updated: 2005

Sites with Enforcement Actions Issued – New Jersey Department of Environmental Protection Open Public Records Act data mining website (datamine.state.nj.us/DEP_OPRA/OpraMain/categories?category=Enforcement%20Actions) Last Updated: May 2005